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USER AND ANALYST MANUAL FOR A FORTRAN COMPUTER PROGRAM SIMULATING THE ENGAGEMENT OF A STATIONARY POINT TARGET BY A STATIONARY DIRECT FIRE WEAPON

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report documents a FORTRAN computer program usable to make effectiveness calculations for weapons that fire aimed rounds one at a time against point targets. The program is applicable to tank main guns and infantry antitank weapons engaging tanks, armored personnel carriers, and other such targets. Monte Carlo techniques are used to simulate the engagement, which does not involve any firing by the target. The required inputs include rate of fire, delivery accuracy, and reliability data for the firing weapon, as well as detailed vulnerability data for the target. Other parameters that must be

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specified are the range, the target orientation and degree of exposure, and the aimpoint. The outputs are hit and kill probabilities for up to 15 rounds, average number of rounds needed for a target hit or kill, as well as hit and kill probabilities for engagement times up to 2 minutes.

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USER AND ANALYST MANUAL FOR A FORTRAN COMPUTER PROGRAM SIMULATING THE ENGAGEMENT OF A STATIONARY POINT TARGET BY A STATIONARY DIRECT FIRE WEAPON

1. INTRODUCTION

This report describes a computer program developed under the sponsorship of the Joint Munitions Effectiveness Manual Surface-to-Surface (JMEM-SS) Methodology and Evaluations Working Group, with a substantial contribution by the Army Materiel Systems Analysis Activity (AMSAA). The program has been used by JMEM-SS and AMSAA to make effectiveness calculations for armor and infantry weapons engaging tanks, armored personnel carriers, and other targets. It utilizes Monte Carlo techniques to simulate the engagement and has been based, to a large extent, on a similar deterministic program previously developed by AMSAA. An earlier version of the JMEM-SS direct fire program has been documented in 1976 by the then US Army Armament Command (Reference 1).

The JMEM-SS direct fire program provides a method for calculating the effectiveness of weapons that fire aimed rounds one at a time against point targets. Such weapons include tank main guns and infantry antitank weapons. The required input includes performance parameters related to the rate of fire, delivery accuracy, and reliability of the firing weapon. A detailed target description and data indicating vulnerability of the target to the type of round fired are also part of the input. Other influencing factors specified for a particular calculation are the range, the orientation of the target, whether the target is fully exposed or only partly exposed, and the aimpoint. To simulate a single engagement, the computer determines the effects of the first round, taking into account several kill criteria of interest. Then, as necessary, second and succeeding rounds up to a limit of 15 rounds are evaluated. Although this limit is a practical one for the calculations, it clearly exceeds the number of rounds normally fired in real combat engagements. The calculations for the first engagement result in an actual possible outcome being established. For example, the target might be determined to be hit on the third round 38 seconds after the start of the engagement. Similar specific numerical values are also assigned to the round number and time corresponding to the target being killed for each kill criterion of concern. The process is repeated until 10,000 engagements have been considered, and data for all engagements are combined to give plausible outputs not unduly influenced by particular engagements. Outputs are:

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[1]Michels, Herman W., An Analyst/User Manual for the Direct Fire Computer Program, DRSAR/SA/R-18, May 1976, US Army Armament Command, Rock Island, IL, 61201.

a. Hit probabilities and kill probabilities corresponding to various numbers of rounds fired.

b. Average numbers of rounds needed to hit or to kill the target.

c. Hit probabilities and kill probabilities for various engagement times up to a practical limit, established as 2 minutes for the calculations.

The engagement simulated by the direct fire program is restricted to being one-sided. This means that the firing weapon is not subjected to return fire from the target or some other opposing element.

This report has been prepared primarily for users and analysts with an interest in documentation far exceeding in scope the very general explanations in this introduction. The material included is as follows:

a. Basic definitions (section 2).
b. General flow of program logic (section 3).
c. Input data (section 4).
d. Output data (section 5).
e. Computer aspects (section 6).
f. Program listing and detailed explanations of program statemerts (Appendixes A and B).

Input data used to exercise the JMEM-SS direct fire program as well as outputs of the calculations frequently require a CONFIDENTIAL classification. To make this user and analyst manual UNCLASSIFIED, input and output data not bearing any identifiable relation to classified information have been fabricated to illustrate inputs and outputs associated with the program.

The direct fire program contains some options that are of little or no concern to most users or analysts. These options are identified in this report but not necessarily discussed thoroughly. If a need for detailed explanations concerning any program option arises, these can be provided by AMSAA upon request.

2. BASIC DEFINITIONS

2.1 Introduction.

This section contains definitions, as well as related assumptions and explanations, intended to clarify the meaning of terms used in this report. The following terms are covered:

Firing Engagement (2.2)
Engagement Time (2.3)
Orientation (2.4)
Exposure (2.5)
Reliability (2.6)
Delivery Accuracy (2.7)
Hit Probability (2.8)
Firing Occasion (2.9)
Fixed Bias (2.10)
Variable Bias (2.11)
Random Error (2.12)
Lay Error (2.13)
Round-to-Round Error (2.14)
Sensing (2.15)
Sensing Probability (2.16)
Sensing Error (2.17)
Target Vulnerability (2.18)
Kill Probability (2.19)
Kill Criterion (2.20)
K,M,F,M Or F (2.21)
K Kill (2.22)
M Kill (2.23)
F Kill (2.24)
M Or F Kill (2.25)
Kill Probability for Specified Number of Rounds Fired (2.26)
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Flight Time (2.31)
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Median Time (2.35)
Variability Factor (2.36)
Minimum Time (2.37)
Kill Probability for Specified Engagement Time (2.38)

2.2 Firing Engagement.

The firing of one or more rounds at a target. Although combat is generally two-sided, engagements simulated in the direct fire program are only one-sided in that the firing weapon is not itself subjected to any fire. It is assumed that neither the target nor the firing weapon changes its position during the engagement. An engagement begins when the decision is made to fire at the target with a particular type of round. The engagement ends when either the target is killed or 15 rounds have been fired. This limit has been established for the calculations to ensure obtaining all data of possible interest. It is realized this limit exceeds the number of rounds available in the ready rack of tanks. Firing engagements in combat could sometimes be deliberately ended for reasons not represented in the computer simulation program. For example, an armored force might have a policy whereby each tank fires no more than some specified number of rounds, like three, at any particular target in certain situations.

2.3 Engagement Time.

Time elapsing from the beginning of the firing engagement. Engagement time increases as the program calculations account for more and more specific events, for example, the firing of the first round and the arrival of this round at the target range. Engagement time can, but does not always, mean the time needed for the entire engagement to be completed.

2.4 Orientation.

The view that the target presents to the firing weapon. Orientation is specified as an angle with 0 degrees representing the front view, 180 degrees the rear view, and 90 and 270 degrees the side view from two opposite directions. Other orientations are represented by angles from 0 to 180 degrees or from 180 to 360 (same as 0) degrees. An observer facing the target and located on the circumference of a circle with the target at its center should move to the right to see the target at orientations of 0 to 180 degrees, and to the left for orientations exceeding 180 degrees.

2.5 Exposure.

Whether the maximum possible target area or only a portion of the maximum area is presented, for a particular orientation, to the firing weapon. Two exposures are normally considered in applications of the direct fire program:

a. Open Exposure: The target presents its maximum presented area for a particular orientation.

b. Defilade Exposure: This condition has been applied only to tank targets. Defilade, or hull defilade, applies to the condition where a tank target presents only its turret as the target. The orientation specified applies to the turret and not the hull since the hull is shielded.

2.6 Reliability.

A measure of the ability of a round to function properly when it is fired and of the fuze to function properly upon impact. Proper functioning basically refers to the absence of catastrophic malfunctions affecting flight of the projectile or fuze action.

2.7 Delivery Accuracy.

A measure of the ability of rounds to hit a target. Delivery accuracy data applying to first rounds and data for subsequent rounds are both needed for the direct fire program calculations.

2.8 Hit Probability.

The chance that, under specific conditions, a target is hit.

2.9 Firing Occasion.

The firing of a small, continuous sequence of rounds at a particular target.

2.10 Fixed Bias.

Errors of the weapon-ammunition-fire control system which are usually constant and predictable at any given range, and are fixed for all firing occasions by the system design. Although the term fixed bias may refer to an individual error, it is used in this report only for the aggregated fixed bias error, in each of the horizontal and vertical directions, that accounts for all applicable individual error sources.

2.11 Variable Bias.

Errors whose values remain very nearly constant during a particular firing occasion, but which may vary considerably from occasion to occasion. Term is used in this report only for the aggregated horizontal or vertical variable bias accounting for all contributing error components.

2.12 Random Error.

Errors or an error whose magnitude and direction vary randomly from round to round even during a single firing occasion. The direct fire program explicitly involves the lay error and the round-to-round error, in each of the horizontal and vertical directions, rather than aggregated random errors.

2.13 Lay Error.

Random error associated with the fine lay made by the gunner before firing.

2.14 Round-to-Round Error.

Random error resulting from differences between individual rounds.

2.15 Sensing.

Process whereby sufficient information concerning the trajectory of a missing round is obtained by the gunner, or by the commander with transmittal to the gunner, as a basis for adjustment of fire before firing of the next round. Sensing is applicable to unguided rounds only.

2.16 Sensing Probability.

The chance that sensing occurs as a basis for adjustment of fire on the next round.

2.17 Sensing Error.

The difference between the weapon aimpoint associated with a missing round that is sensed and the new aimpoint following adjustment of fire. Such differences account not only for incorrect judgments about where missing rounds went and possibly inaccuracies arising from transmittal of information from the commander to the gunner, but also for any errors made by the gunner in relaying as part of the fire adjustment process. The sensing error in each of the horizontal and vertical directions is of concern for the direct fire program calculations involving unguided rounds.

2.18 Target Vulnerability.

A measure of the target's susceptibility to sustain a given amount of damage when hit by a round.

2.19 Kill Probability.

The chance that a target is killed as a consequence of damage sustained. The word kill acquires a definite meaning when it is associated with a specific kill criterion.

2.20 Kill (Damage) Criterion.

The function or functions that a target must lose to be considered out of action. A target killed in one engagement could be repaired and participate in a subsequent engagement.

2.21 K, M, F, M Or F.

Symbols representing four kill criteria whose specific definitions have been used, by the United States and several other countries, as the basis for vulnerability analyses of armored vehicles.

2.22 K Kill.

A target vehicle is subjected to a K kill (complete destruction) if it sustains both an M kill and an F kill and is damaged to the extent that it is not economically repairable. A K kill is more likely to be apparent to the crew of the firing weapon than any other kill because of resulting fires and/or detonation of ammunition.

2.23 M Kill.

A target is subjected to an M kill (mobility) if it is incapable of executing controlled movement and the damage is not repairable by the crew on the battlefield. The loss of this function may be caused by either incapacitation of the crew or damage to the propulsion or control equipment. A target that is M killed could sustain other types of damage at the same time, i.e., F kill or K kill.

2.24 F Kill.

A target is subjected to an F kill (firepower) if it is incapable of delivering controlled fire from the main armament and the damage is not repairable by the crew on the battlefield. The loss of this function may be caused by either incapacitation of the crew or damage to the main armament and its associated equipment. A target that is F killed could sustain other types of damage at the same time, i.e., M kill or K kill.

2.25 M Or F Kill.

A vehicle is subjected to an M or F kill if it sustains either an M kill or an F kill, or both an M kill and F kill. A target that sustains an M or F kill could also at the same time sustain a K kill.

2.26 Kill Probability for Specified Number of Rounds Fired.

Probability that the target is killed when a specific number of rounds, say N, are fired. This probability is meaningful only in conjunction with a kill criterion. N is considered to equal 1 through 15 for the program calculations. The kill probability associated with N rounds is an aggregated result that accounts for kills caused by any round up to and including the Nth round. When N equals 2, the second round is fired only when the first does not kill the target. More generally, any round after the first is fired only when the target has not already been killed.

2.27 Average Number of Rounds Needed to Kill Target.

The average number of rounds needed to kill a target is the arithmetic average of the number of rounds needed to achieve a specified type of kill given an unlimited number of individual firing engagements. Although engagements are not continued beyond 15 rounds, the program calculations account for additional rounds needed in exceptional instances where the target may survive 15 rounds. It is not implied by this that such large numbers of rounds would be involved in an actual combat engagement.

2.28 Expected Personnel Casualties.

Refer to the average, or expected, number of personnel casualties sustained by the troops carried in an armored personnel carrier target. Crew members are excluded. Calculations of personnel casualties have been based on the assault --- 5-minute criterion, which means a man must be rendered incapable of performing an assault role within 5 minutes after being wounded in order to be considered a casualty.

2.29 Rate of Fire.

A measure of the ability of a weapon to fire aimed rounds at a target. The direct fire program requires input data permitting the computer to generate the distribution of times, not only average times, that crews would need to fire the weapon in a firing engagement. Furthermore, care is necessary to ensure that the inputs correspond to rate of fire under combat conditions rather than test conditions generally tending to favor rapid fire.

2.30 First Round Firing Time.

Time elapsing between the beginning of the engagement and firing of the first round. Operations involved in firing of the first round include, as applicable, the following:

a. Slewing of the weapon.

b. Target recognition by the gunner.

c. Ranging, which may be done with equipment, such as a rangefinder, or by visual estimation of the range to the target.

d. Laying of the weapon.

Note that some of these operations can be carried out at the same time that others are. Loading of the first round may be included or excluded. In the latter case, the appropriate type of round is considered already loaded before recognition of the target.

2.31 Flight Time.

Time interval between the time a round begins to be propelled forward in the gun or launcher and the time it reaches the range of the target.

2.32 Subsequent Round Firing Time.

Time that elapses between firing of any round and firing of the next round against the same target. Subsequent round firing time involves,

as applicable, the following:

a. Flight time of the previous round.

b. Round loading.

c. Relaying of the weapon, which may or may not reflect efforts to improve the aimpoint with reference to the aimpoint used for the previous round.

2.33 Fixed Time.

Portion of total firing time, for a first or a subsequent round, that is independent of environmental conditions, crew skill and level of training, or other causes of variation in firing time performance. This time is frequently associated with mechanical operations, such as automatic loading, for unguided rounds or with flight time of the previous round for missiles.

2.34 Variable Time.

Component of total first round or subsequent round firing time that needs to be represented by a distribution of times, rather than by a fixed time component. On any particular firing occasion, total firing time equals the sum of the applicable fixed time component and a particular time from the distribution describing the variable time component. Variable time is tied to human operations and generally tends not to equal zero, because there exist so many causes of variation that are not controllable, at least completely.

2.35 Median Time.

Median time can be defined as the particular time which is greater than half the times represented by the corresponding distribution and smaller than the remaining half. For the special case where a logarithmiconormal distribution is fitted to data consisting of N particular times, the median time is the Nth root of the product of all times in the set of data considered. Alternatively, for this special case, the median time is the antilogarithm of the arithmetic mean of the N logarithms corresponding to the times constituting the basic data. Detailed studies made many years ago established that logarithmiconormal distributions seemed to correspond more closely than other known distributions to test data obtained for tank weapons of interest at the time. Distributions of this type are still considered useful to represent variable components of firing times for weapons of current concern.

2.36 Variability Factor.

Factor indicating to what extent the times represented by logarithmiconormal distributions vary with reference to the applicable median times. A factor of about 0.5 (based on calculations with natural logarithms) has been found to apply consistently and is normally used, except when a specific reason for doing otherwise is identified. This factor is the standard deviation of the natural logarithms of time data for a particular set of conditions with reference to the natural logarithm of the median time.

2.37 Minimum Time.

Least time considered possible. Such a least time, if one other than zero is specified, can be made to override any unrealistically shorter times that may be implied by a particular time distribution used.

2.38 Kill Probability for Specified Engagement Time.

Probability that the target is killed when a specific engagement time, say T seconds, has elapsed since the beginning of the firing engagement. Specification of a kill criterion is also necessary. T is considered to equal 0 to 120 seconds for the program calculations. The kill probability associated with any specific time T is an aggregated result that accounts for kills that occur at any time up to T.

3. GENERAL FLOW OF PROGRAM LOGIC

3.1 Introduction.

This section provides a general indication of the principal steps involved in the simulation of firing engagements. Such an indication, which may suffice for many readers, is supplemented by the detailed explanations of the program logic that are contained in the appendixes.

3.2 Principal Program Steps.

The program instructions cause the computer to perform a sequence of steps. The flow can be complicated, principally when special purpose options are exercised. The principal steps for the basic program (exclusive of special purpose options) are as follows:

a. Read input cards for the weapon/round/fire control type, target type, target exposure conditions, and range involved.

b. Make all necessary adjustments to the card input data just read; for example, some data may require conversion from meters to inches.

c. Skip any files on the vulnerability data tape that precede the kill probability and personnel casualty data needed.

d. Read kill probability data from the vulnerability data tape for target orientation angles of 0 and 180, 30 and 210, 60 and 240, and 90 and 270 degrees. The two angles in each pair correspond to reverse directions. It is convenient to refer to the first angle as basic and to the second as the corresponding reverse angle. Steps e through j apply, in turn, to each pair of basic and reverse directions.

e. Simulate the first firing engagement for the basic orientation angle. See 3.3 for details.

f. Simulate the second firing engagement for the basic orientation angle, as for e.

g. Likewise, simulate additional engagements until a total of 10,000 engagements for the basic orientation angle has been reached.

h. Repeat steps e through g for the reverse orientation angle.

i. Combine data from all 10,000 firing engagements for each angle of the matched pair of concern to determine the hit probability and kill probabilities corresponding to 1, 2, 3, etc., 14, 15 rounds, the average, or expected, numbers of rounds needed to hit or to kill the target, and the hit and kill probabilities corresponding to engagement times of 0, 2, 4, etc., 118, 120 seconds.

j. Print as output the results obtained in step i.

3.3 Program Steps for Single Engagement at Particular Angle.

Simulation of a single firing engagement for a particular orientation angle begins with consideration of the first main round fired. Steps involved are as follows:

a. Determine the number of seconds between the beginning of the engagement and the arrival of the first round at the target range.

b. Determine if the first round flies reliably. If not, the target cannot be hit or killed and calculations for the next round begin immediately without any credit for sensing of the first round as a basis for adjustment of fire.

c. If the first round has a reliable flight trajectory, determine the impact point in the plane of the target and whether or not the target is hit.

d. If the first round misses the target, determine whether the round is sensed and begin calculations for the next round. The calculations for the next round eventually reflect whether or not adjustment of fire, to take advantage of information obtained by sensing, has been possible.

e. If the round hits, determine whether reliable functioning of the fuze occurs. If not, the target cannot be killed and calculations for the next round begin without any further consideration of possible damaging effects on the target.

f. If damaging effects are to be assessed, determine whether each of the various types of kill, i.e., M kill, F kill, M or F kill, and K kill, is inflicted on the target. Continue with the calculations for the second round whenever there is at least one kill criterion according to which the target has not been killed by the first round. If the target has been killed according to all criteria, proceed to simulation of the second firing engagement.

Unless the engagement is over, simulate firing of the second main round as follows:

g. Determine the number of seconds between firing of the first round and firing of the second round. Add this number to the time of arrival of the first round at the target range to obtain the time between the start of the engagement and the arrival of the second round at the target range.

h. Determine if the second round flies reliably. If not, proceed as for b above, i.e., begin calculations for the next round.

i. If the second round has a reliable flight trajectory, determine the impact point in the plane of the target and whether or not the target is hit, as for c. The second round is assumed fired with the same aimpoint as for the first round if the latter is not sensed, or with a new aimpoint based on sensing information.

j. If the second round misses the target, determine whether the round is sensed and begin calculations for the next round, as for d.

k. If the round hits, determine whether damaging effects are not to be assessed because of unreliable functioning of the fuze. If the fuze does not function reliably, begin calculations for the next round, as for e.

l. If damaging effects on the target are to be assessed, determine whether each of the various types of kill still being considered is inflicted on the target. Continue with the calculations for the third round whenever there is at least one kill criterion according to which the target has not yet been killed, or proceed to simulation of the second firing engagement.

If the engagement is not yet over after two rounds, simulate firing of the third round and succeeding rounds, as necessary, but not beyond the fifteenth round. Steps g through l also apply to each round following the second round. Times at which rounds arrive at the target range are ignored whenever these times are beyond 2 minutes from the start of the engagement.

3.4 Special Options.

Listing of the various special options available is not attempted here. Two examples, selected somewhat arbitrarily, are as follows:

a. A vulnerability data tape or disc is not absolutely required. It may be possible to substitute a set of input cards containing detailed target shape information identical to that on the tape or disc. Target shape data are sufficient if hit probabilities, but not kill probabilities, need to be computed. Although it would be possible to use input cards, rather than a tape or disc, for detailed vulnerability data also, this is impractical.

b. Calculations can be made for simplified engagements each involving the firing of only one round. In particular, single round hit probabilities and kill probabilities can be obtained for a moving target or a moving firing tank. However, this does not imply that the program can actually simulate in detail the movement of the target or firing tank.

4. INPUT DATA

4.1 Introduction.

The direct fire program can make calculations for several combinations of conditions considered in sequence. However, it is sufficient for this report to emphasize a single basic cycle definable as all the calculations for:

a. A specified firing weapon, round type, and fire control system.

b. A particular target.

c. One target exposure condition, i.e., the target is fully exposed or in defilade.

d. One range.

e. One of the orientation angles 0, 30, 60, or 90 degrees and the corresponding angle for the reverse direction. Matched pairs of angles are 0 and 180, 30 and 210, 60 and 240, and 90 and 270 degrees.

The input data required for a single basic cycle consist of both a set of cards, and normally, a tape or disc file. The cards contain control quantities as well as information related to aimpoint, reliability, delivery accuracy, and rate of fire. The tape or disc provides target vulnerability data.

This report documents the input data used for a sample computer run and the corresponding output results. For this sample run, it was more important to illustrate input and output quantities in detail than to consider weapon, target, and other combat engagement conditions of real concern. The inputs developed for the purpose just stated are identified in this section. They are suitable for illustrating input requirements and formats in detail and, while possibly similar to classified data of actual interest, are not applicable to a specific set of engagement conditions.

4.2 Card Inputs.

Contents of the input cards required to run the direct fire program are listed and briefly described in Table 4.1. The role of some input quantities should be evident from the table. Several other quantities, however, can be fully understood only in connection with detailed explanations subsequently provided. Cards numbered 1 through 5 contain controls needed for each computer run and applicable to each range regardless of how many ranges are grouped for the run. Integer controls are on the first three of these cards, and real quantities on the last two cards. Cards numbered R1 through R8 are needed for each range. Except for the integer controls

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS

CARD	COLUMNS	SYMBOL	FORMAT	EXAMPLE	UNITS	EXPLANATION OF SYMBOL
1	1-10	IDCODE	10A1	R159851340		CODE CONSISTING OF RUN IDENTIFIER (R15 IN EXAMPLE), ROUND IDENTIFIER(985), AND TARGET IDENTIFIER(1340)
2	1- 5	NRSKP	I5	3		NUMBER OF VULNERABILITY DATA FILES TO BE SKIPPED ON TAPE OR DISC TO REACH FIRST FILE FOR ROUND/TARGET COMBINATION INVOLVED IN RUN
	6-10	NCASES	I5	10		NUMBER OF RANGES GROUPED TOGETHER FOR COMPUTER RUN
	11-15	NRFRST	I5	250	METERS	FIRST RANGE INVOLVED IN CALCULATIONS
	16-20	NTGT	I5	2		TARGET TYPE CODE ASSOCIATED WITH FORMAT USED TO ENTER VULNERABILITY DATA ON TAPE OR DISC
	21-25	NRDTYP	I5	0		ROUND TYPE CODE SET TO 0 IF VULNERABILITY DATA DO NOT VARY WITH RANGE, OR 1 OTHERWISE
	26-30	NRD1	I5	0		CONTROL SET TO 1 IF ONLY ONE ROUND IS OF INTEREST FOR EACH ENGAGEMENT, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	31-35	NRDS	I5	15		MAXIMUM NUMBER OF ROUNDS TO BE FIRED PER ENGAGEMENT
	36-40	NADJST	I5	0		CONTROL SET TO 1, 2, 3, 4, OR 5 IF ASSOCIATED ADJUSTMENT PROCEDURE IS TO BE USED AFTER MISSING ROUND, OR 0 FOR BASIC PROCEDURE INVOLVING ADJUSTMENT BASED ON SENSING WHEN POSSIBLE AND RELAYING ON PREVIOUS AIMPOINT OTHERWISE
	41-45	NRFBS	I5	1		CONTROL SET TO 1 IF AIMPOINT IS APPROXIMATE CENTER OF MASS OF TARGET (AS WHEN RANGING IS DONE WITH RANGEFINDER), OR 2 IF VERTICAL COORDINATE OF AIMPOINT CORRESPONDS TO BASE OF TARGET (AS WHEN BATTLESIGHT IS USED)
	46-50	NDROP	I5	0		CONTROL SET TO 1, 2, 3, 4, 5, OR 6 WHEN VERTICAL CHANGE IS INVOLVED IN ADJUSTMENT PROCEDURE AFTER MISSING ROUND THAT IS NOT SENSED, OR 0 OTHERWISE

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS (CONTINUED)

	51-55	NHIT	I5	0	CONTROL SET TO ANY NUMBER NOT 0 (1 PREFERRED) IF AIMPOINT IS TO BE ADJUSTED TOWARD TARGET CENTER AFTER TARGET IS HIT, OR 0 OTHERWISE
	56-60	NPRHIT	I5	0	CONTROL SET TO 1 IF HIT PROBABILITIES ARE ONLY DESIRED OUTPUT, OR 0 OTHERWISE
	61-65	NDTRM1	I5	0	CONTROL SET TO 1 IF REHIT PROBABILITY OF SECOND ROUND AFTER FIRST ROUND HIT IS TO BE CALCULATED DETERMINISTICALLY WITH DATA FROM MONTE CARLO ENGAGEMENTS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	66-70	NDTRM2	I5	0	CONTROL SET TO 1 IF REHIT PROBABILITY OF SECOND ROUND AFTER FIRST ROUND HIT THAT DOES NOT CAUSE K KILL IS TO BE CALCULATED DETERMINISTICALLY WITH DATA FROM MONTE CARLO ENGAGEMENTS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
3	1- 5	NDTRM3	I5	0	CONTROL SET TO 1 IF HIT PROBABILITY OF SECOND ROUND AFTER FIRST ROUND MISS IS TO BE CALCULATED DETERMINISTICALLY WITH DATA FROM MONTE CARLO ENGAGEMENTS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	6-10	NDTRM4	I5	0	CONTROL SET TO 1 IF HIT PROBABILITY OF SECOND ROUND AFTER SENSED MISS ON FIRST ROUND IS TO BE CALCULATED DETERMINISTICALLY WITH DATA FROM MONTE CARLO ENGAGEMENTS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	11-15	NDTRM5	I5	0	CONTROL SET TO 1 IF HIT PROBABILITY OF SECOND ROUND AFTER UNSENSED MISS ON FIRST ROUND IS TO BE CALCULATED DETERMINISTICALLY WITH DATA FROM MONTE CARLO ENGAGEMENTS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	16-20	NHTKLL	I5	0	CONTROL SET TO 0 IF DETERMINISTIC CALCULATIONS OF CERTAIN HIT AND KILL PROBABILITIES ARE NOT TO BE MADE WITH DATA FROM INPUT CARDS, 9 IF SUCH CALCULATIONS ARE TO BE MADE AND RESULTS TO CONSTITUTE ONLY OUTPUT, OR ANY NUMBER NOT 0 OR 9 (1 PREFERRED) IF SUCH CALCULATIONS ARE TO BE MADE IN ADDITION TO SIMULATION OF MONTE CARLO ENGAGEMENTS

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS (CONTINUED)

	21-25	NTCRD1	I5	0		CONTROL SET TO 1 IF INPUT CARD DATA ARE NEEDED TO DESCRIBE SHAPE OF 0 DEGREE TARGET, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	26-30	NTCRD2	I5	0		CONTROL SET TO 1 IF INPUT CARD DATA ARE NEEDED TO DESCRIBE SHAPE OF 30 DEGREE TARGET, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	31-35	NTCRD3	I5	0		CONTROL SET TO 1 IF INPUT CARD DATA ARE NEEDED TO DESCRIBE SHAPE OF 60 DEGREE TARGET, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	36-40	NTCRD4	I5	0		CONTROL SET TO 1 IF INPUT CARD DATA ARE NEEDED TO DESCRIBE SHAPE OF 90 DEGREE TARGET, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
4	1-10	PASSN	F10.4	6.0000	MEN	NUMBER OF TARGET PASSENGER PERSONNEL, EXCLUDING CREW
	11-20	WCELL	F10.4	4.0000	INCHES OR MILLIMETERS	DIMENSION OF EACH TARGET CELL, WHICH CAN BE ONLY 4.0000 FOR 4 INCHES OR 100.0000 FOR 100 MILLIMETERS
	21-30	XC	F10.4	0.0000	LIKE WCELL	HORIZONTAL COORDINATE OF POINT CHOSEN AS APPROXIMATE CENTER OF MASS OF TARGET
	31-40	YC	F10.4	-28.0000	LIKE WCELL	VERTICAL COORDINATE OF POINT CHOSEN AS APPROXIMATE CENTER OF MASS OF TARGET
	41-50	YBASE	F10.4	-70.0000	LIKE WCELL	MINIMUM VERTICAL COORDINATE OF UNSHIELDED PORTION OF TARGET
	51-60	YTOP	F10.4	9999.9999	LIKE WCELL	VERTICAL COORDINATE OF POINT CHOSEN AS APPROXIMATE TOP OF TARGET. USUALLY UNNEEDED AND SET TO 9999.9999. ANY OTHER SETTING INDICATES ADJUSTMENT PROCEDURE ASSOCIATED WITH NDROP EQUALLING 1 APPLIES AFTER MISSING ROUND.
	61-70	RELT	F10.4	0.9900		PROBABILITY OF RELIABLE PROJECTILE FLIGHT FOR EACH ROUND FIRED
5	1-10	RELF	F10.4	0.9280		PROBABILITY OF RELIABLE FUZE FUNCTIONING FOR EACH ROUND FIRED

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS (CONTINUED)

R1	1- 5	IRANGE	I5	250	METERS	TARGET RANGE
	6-10	INTPL	I5	0		RANGE INTERPOLATION CONTROL SET TO 1 IF NRDTYP EQUALS 1 AND IRANGE IS NOT MULTIPLE OF 500 METERS, OR ANY NUMBER NOT 1 (0 PREFERRED) OTHERWISE
	11-15	IMILS	I5	0		CONTROL SET TO 0 FOR METERS OR 1 FOR MILS TO INDICATE UNITS CHOSEN FOR VARIOUS DATA ON CARDS R3 THROUGH R8
R2	1-10	FLT	F10.4	1.7100	SECONDS	PROJECTILE TIME OF FLIGHT
	11-20	TF1	F10.4	0.0000	SECONDS	FIXED FIRING TIME FOR FIRST ROUND
	21-30	TFS	F10.4	0.0000	SECONDS	FIXED FIRING TIME FOR EACH SUBSEQUENT ROUND
	31-40	XM1	F10.4	19.8000	SECONDS	MEDIAN VARIABLE FIRING TIME FOR FIRST ROUND
	41-50	XM2	F10.4	15.6000	SECONDS	MEDIAN VARIABLE FIRING TIME FOR EACH SUBSEQUENT ROUND
	51-60	AMT1	F10.4	0.0000	SECONDS	MINIMUM FIRING TIME FOR FIRST ROUND
	61-70	AMT2	F10.4	0.0000	SECONDS	MINIMUM FIRING TIME FOR EACH SUBSEQUENT ROUND
R3	1-10	STD1	F10.4	0.0000		TIME VARIABILITY FACTOR FOR FIRST ROUND
	11-20	STD2	F10.4	0.0000		TIME VARIABILITY FACTOR FOR EACH SUBSEQUENT ROUND
	21-30	XB	F10.4	0.0357	METERS OR MILS	HORIZONTAL FIXED BIAS FOR FIRST ROUND
	31-40	YB	F10.4	1.0161	METERS OR MILS	VERTICAL FIXED BIAS FOR FIRST ROUND
	41-50	SIGXB	F10.4	2.7038	METERS OR MILS	HORIZONTAL VARIABLE BIAS STANDARD DEVIATION FOR FIRST ROUND
	51-60	SIGYB	F10.4	5.5923	METERS OR MILS	VERTICAL VARIABLE BIAS STANDARD DEVIATION FOR FIRST ROUND
	61-70	SIGXL	F10.4	0.2277	METERS OR MILS	HORIZONTAL LAY ERROR STANDARD DEVIATION FOR FIRST ROUND
R4	1-10	SIGYL	F10.4	0.2277	METERS OR MILS	VERTICAL LAY ERROR STANDARD DEVIATION FOR FIRST ROUND
	11-20	SIGXR	F10.4	0.6136	METERS OR MILS	HORIZONTAL ROUND-TO-ROUND ERROR STANDARD DEVIATION
	21-30	SIGYR	F10.4	0.6872	METERS OR MILS	VERTICAL ROUND-TO-ROUND ERROR STANDARD DEVIATION
	31-40	PROBS	F10.4	0.7800		PROBABILITY OF GUNNER AND/OR COMMANDER SENSING MISSING ROUND
	41-50	SIGXS	F10.4	1.4635	METERS OR MILS	HORIZONTAL SENSING ERROR STANDARD DEVIATION

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS (CONTINUED)

	51-60	SIGYS	F10.4	1.4635	METERS OR MILS	VERTICAL SENSING ERROR STANDARD DEVIATION
	61-70	PGH	F10.4			PROBABILITY OF GUNNER SENSING ROUND THAT MISSES HIGH
R5	1-10	PGS	F10.4			PROBABILITY OF GUNNER SENSING ROUND THAT MISSES SHORT
	11-20	PGCH	F10.4			PROBABILITY OF GUNNER AND/OR COMMANDER SENSING ROUND THAT MISSES HIGH
	21-30	PGCS	F10.4			PROBABILITY OF GUNNER AND/OR COMMANDER SENSING ROUND THAT MISSES SHORT
	31-40	SGHX	F10.4		METERS OR MILS	HORIZONTAL SENSING ERROR STANDARD DEVIATION FOR GUNNER SENSING OF ROUND THAT MISSES HIGH
	41-50	SGHY	F10.4		METERS OR MILS	VERTICAL SENSING ERROR STANDARD DEVIATION FOR GUNNER SENSING OF ROUND THAT MISSES HIGH
	51-60	SGSX	F10.4		METERS OR MILS	HORIZONTAL SENSING ERROR STANDARD DEVIATION FOR GUNNER SENSING OF ROUND THAT MISSES SHORT
	61-70	SGSY	F10.4		METERS OR MILS	VERTICAL SENSING ERROR STANDARD DEVIATION FOR GUNNER SENSING OF ROUND THAT MISSES SHORT
R6	1-10	CDRX	F10.4		METERS OR MILS	HORIZONTAL ADD-ON SENSING ERROR STANDARD DEVIATION TO BE COMBINED WITH SGHX OR SGSX FOR COMMANDER SENSING OF MISSING ROUND
	11-20	CDRY	F10.4		METERS OR MILS	VERTICAL ADD-ON SENSING ERROR STANDARD DEVIATION TO BE COMBINED WITH SGHY OR SGSY FOR COMMANDER SENSING OF MISSING ROUND
	21-30	HSX	F10.4		METERS OR MILS	HORIZONTAL ERROR STANDARD DEVIATION FOR GUNNER ADJUSTMENT OF HITTING ROUND TOWARD TARGET CENTER
	31-40	HSY	F10.4		METERS OR MILS	VERTICAL ERROR STANDARD DEVIATION FOR GUNNER ADJUSTMENT OF HITTING ROUND TOWARD TARGET CENTER
	41-50	XBH	F10.4		METERS OR MILS	HORIZONTAL FIXED BIAS FOR ROUND FOLLOWING HITTING ROUND
	51-60	YBH	F10.4		METERS OR MILS	VERTICAL FIXED BIAS FOR ROUND FOLLOWING HITTING ROUND
	61-70	SIGXBH	F10.4		METERS OR MILS	HORIZONTAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING HITTING ROUND

TABLE 4.1 CONTENTS OF PROGRAM INPUT CARDS (CONTINUED)

R7	1-10	SIGYBH	F10.4	METERS OR MILS	VERTICAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING HITTING ROUND
	11-20	XBL	F10.4	METERS OR MILS	HORIZONTAL FIXED BIAS FOR ROUND FOLLOWING MISSING ROUND THAT IS NOT SENSED
	21-30	YBL	F10.4	METERS OR MILS	VERTICAL FIXED BIAS FOR ROUND FOLLOWING MISSING ROUND THAT IS NOT SENSED
	31-40	SIGXBL	F10.4	METERS OR MILS	HORIZONTAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING MISSING ROUND THAT IS NOT SENSED
	41-50	SIGYBL	F10.4	METERS OR MILS	VERTICAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING MISSING ROUND THAT IS NOT SENSED
	51-60	XBS	F10.4	METERS OR MILS	HORIZONTAL FIXED BIAS FOR ROUND FOLLOWING MISSING ROUND THAT IS SENSED
	61-70	YBS	F10.4	METERS OR MILS	VERTICAL FIXED BIAS FOR ROUND FOLLOWING MISSING ROUND THAT IS SENSED
R8	1-10	SIGXBS	F10.4	METERS OR MILS	HORIZONTAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING MISSING ROUND THAT IS SENSED
	11-20	SIGYBS	F10.4	METERS OR MILS	VERTICAL VARIABLE BIAS STANDARD DEVIATION FOR ROUND FOLLOWING MISSING ROUND THAT IS SENSED

on the R1 card, all input data on these cards are real. The EXAMPLE column of Table 4.1 contains the data used for the run that yielded the sample outputs presented in section 5. Since IMILS is set to 0, meters are the unit associated with cards R3 through R6. Blanks on cards R4 through R8 correspond to input quantities associated with special options that were not exercised in the sample run.

The manner in which input data are actually arranged on cards is illustrated in Table 4.2. This table contains the same inputs as the previous one. The first portion of the table shows how the basic control cards (identifiable by R15 A, B, C, D, E entered in the last 8 columns) are followed by the 8 cards corresponding to 250 meters (identifiable by R15 2501, 2, 3, 4, 5, 6, 7, 8 in these same columns). The 250-meter cards would be followed if necessary by similar groups of 8 cards for other ranges. The remainder of the table repeats the card images, with headings added to facilitate relating each quantity to the explanatory information in Table 4.1.

4.3 Tape or Disc Inputs.

Vulnerability data constituting needed tape or disc input information are generated by the Vulnerability Division of the Ballistic Research Laboratory (BRL). These data are extensive in scope and consist of kill probabilities for a large number of specific impact points on the target. These impact points are selected from the grid squares obtained by dividing the target as shown in Figure 4.1. These squares, usually called cells, are either 4 inches (101.6mm) or 100mm on each side. One impact point is chosen from each cell and data developed for that point are then considered representative of the effects of a hit anywhere on the cell. Table 4.3 illustrates a portion of the data. The associated conditions are not identifiable, since fictitious projectile, target, and range headings appear in the table. The coordinates X and Y are those of the center of each cell and refer to a suitably selected origin, e.g., at the turret center line for some tank targets or at the base of the target. Each line of data includes probabilities of M kill, F kill, M or F kill (M/F in the table), and K kill, as well as expected casualties when applicable, given a hit on the cell of interest for both a basic orientation angle and the corresponding reverse angle. Note that the reverse angle corresponding here to 30 degrees is 150 degrees. This reflects the assumption, established by BRL, that a single set of vulnerability data can reasonably be used for symmetrically related directions, like 150 and 210 degrees, that represent attack of a target from the right in one instance and from the left in the other.

The vulnerability data used for the sample computer run differ from those partly shown in Table 4.3, but need not be identified further.

The points labelled A, B, C, and D in Figure 4.1 are the corners of a rectangle just large enough to enclose the target representation. Such a rectangle is referred to in some of the explanations in Appendix A.

TABLE 4.2 SAMPLE INPUT CARD DATA

```
R159851340                                                                  R15     A
    3   10  250    2    0    0   15    0    1    0    0    0    0    0     R15     B
    0    0    0    0    0    0    0    0                                   R15     C
    6.0000    4.0000    0.0000  -28.0000  -70.0000 9999.9999    0.9900     R15     D
    0.9280                                                                  R15     E
  250    0    0                                                            R15  2501
    1.7100    0.0000    0.0000   19.8000   15.6000    0.0000    0.0000     R15  2502
    0.0000    0.0000    0.0357    1.0161    2.7038    5.5923    0.2277     R15  2503
    0.2277    0.6136    0.6872    0.7800    1.4635    1.4635              R15  2504
                                                                          R15  2505
                                                                          R15  2506
                                                                          R15  2507
                                                                          R15  2508
```



```
        COLUMNS
          1         2         3         4         5         6         7   7       8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

   CARD R15     A     IDCODE
R159851340                                                                  R15     A

   CARD R15     B     NRSKP,NCASES,NRFRST,NTGT,NRDTYP,NRD1,NRDS,NADJUST,
                        NRFBS,NDROP,NHIT,NPRHIT,NDTRM1,NDTRM2
    3   10  250    2    0    0   15    0    1    0    0    0    0    0     R15     B

   CARD R15     C     NDTRM3,NDTRM4,NDTRM5,NHTKLL,NTCRD1,NTCRD2,NTCRD3,
                        NTCRD4
    0    0    0    0    0    0    0    0                                   R15     C

   CARD R15     D     PASSN,WCELL,XC,YC,YBASE,YTOP,RELT
    6.0000    4.0000    0.0000  -28.0000  -70.0000 9999.9999    0.9900     R15     D
```

TABLE 4.2 SAMPLE INPUT CARD DATA (CONTINUED)

```
CARD R15    E    RELF
 0.9280                                                          R15    E

CARD R15 2501    IRANGE,INTPL,IMILS
250    0    0                                                   R15 2501

CARD R15 2502    FLT,TF1,TFS,XM1,XM2,AMT1,AMT2
 1.7100    0.0000    0.0000    19.8000    15.6000    0.0000    0.0000  R15 2502

CARD R15 2503    STD1,STD2,XB,YB,SIGXB,SIGYB,SIGXL
 0.0000    0.0000    0.0357    1.0161    2.7038    5.5923    0.2277  R15 2503

CARD R15 2504    SIGYL,SIGXR,SIGYR,PROBS,SIGXS,SIGYS,PGH
 0.2277    0.6136    0.6872    0.7800    1.4635    1.4635          R15 2504

CARD R15 2505    PGS,PGCH,PGCS,SGHX,SGHY,SGSX,SGSY
                                                                  R15 2505

CARD R15 2506    CDRX,CDRY,HSX,HSY,XBH,YBH,SIGXBH
                                                                  R15 2506

CARD R15 2507    SIGYBH,XBL,YBL,SIGXBL,SIGYBL,XBS,YBS
                                                                  R15 2507

CARD R15 2508    SIGXBS,SIGYBS
                                                                  R15 2508
```

Note: A, B, C, and D are corners of rectangle enclosing target.

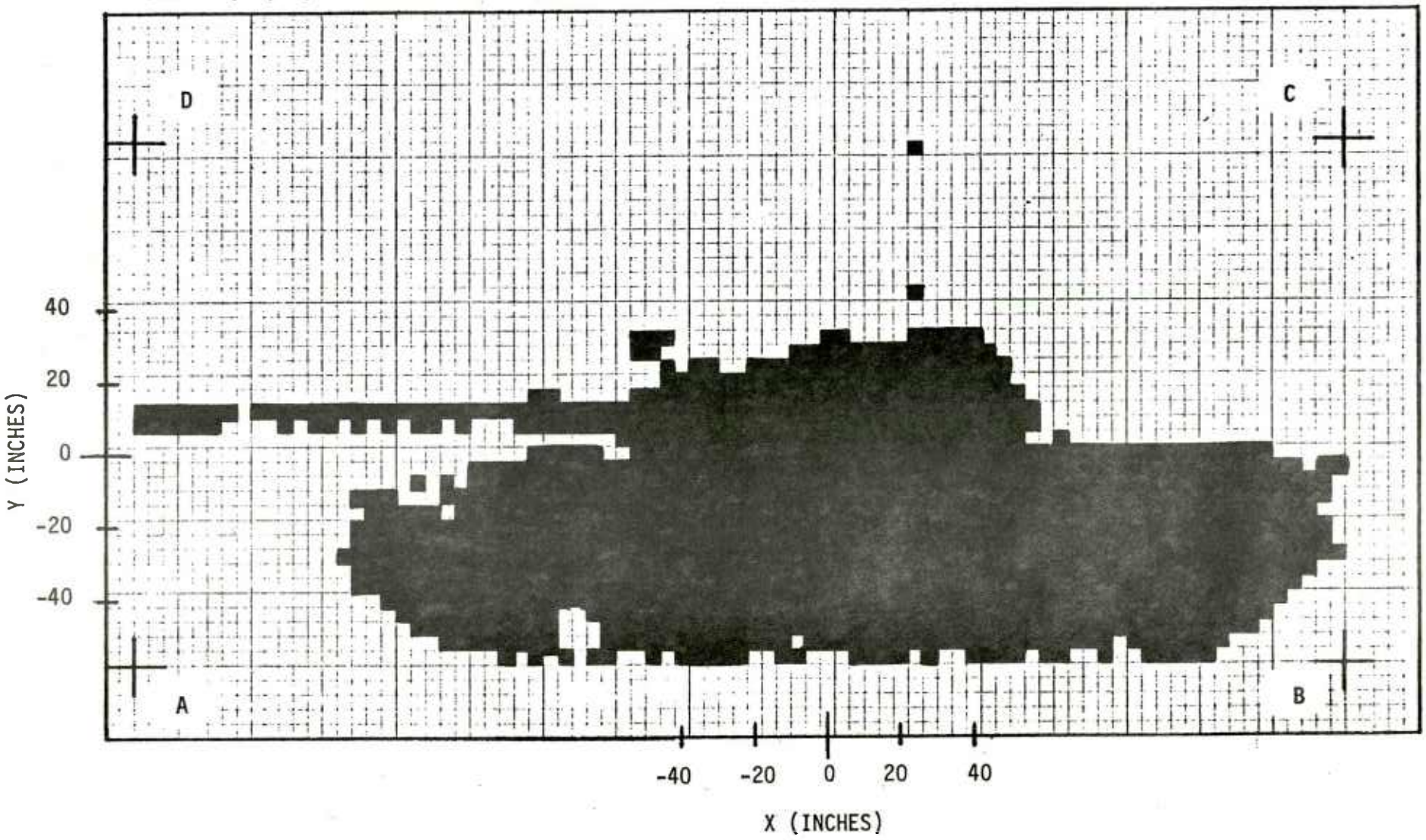

FIGURE 4.1 MEDIUM TANK TARGET AT ORIENTATION OF 60 DEGREES

TABLE 4.3 SAMPLE DATA FROM VULNERABILITY TAPE

PROJECTILE 985 AT 1500 METERS RANGE VS. VEHICLE 1340 5/77

		0 DEG ELEV, 30 DEG AZIM					0 DEG ELEV, 150 DEG AZIM				
X	Y	M	F	M/F	K	EC	M	F	M/F	K	EC
- 4.0	88.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
20.0	88.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
24.0	88.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
- 4.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
8.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
24.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
28.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
32.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
36.0	84.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
4.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
8.0	80.0	.0	.250	.250	.0	.0	.0	.0	.0	.0	.0
12.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
16.0	80.0	.0	.250	.250	.0	.0	.0	.0	.0	.0	.0
20.0	80.0	.0	.0	.0	.0	.0	.0	.250	.250	.0	.0
28.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
32.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
36.0	80.0	.0	.250	.250	.0	.0	.0	.0	.0	.0	.0
40.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
44.0	80.0	.0	.0	.)(	.0	.0	.0	.250	.250	.0	.0
52.0	80.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
4.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
8.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
12.0	76.0	.0	.437	.437	.0	.0	.0	.437	.437	.0	.0
16.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
20.0	76.0	.0	.437	.437	.0	.0	.0	.437	.437	.0	.0
24.0	76.0	.0	.437	.437	.0	.0	.0	.437	.437	.0	.0
28.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
32.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
36.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
40.0	76.0	.0	.250	.250	.0	.0	.0	.250	.250	.0	.0
E T C											
999.9											

4.4 Requirements for Special Options.

A special option, already mentioned in 3.4, permits using input cards with target shape information instead of the vulnerability data tape or disc normally required for a run. Card requirements associated with this option are illustrated in Table 4.4. Numbers are grouped by threes. For example, 76, -28, -8 mean that the target includes an unbroken string of cells whose centers have coordinates (-28,76), (-24,76), (-20,76), (-16,76), (-12,76), and (-8,76), while 88, -24, -24 simply identify an isolated cell the coordinates of whose center are (-24,88). The total target can thus be specified as a combination of horizontal strips of cells and, normally, some isolated cells toward the edges. The target shape card option has been restricted to only four orientations, namely, 0, 30, 60, and 90 degrees, identified in columns 77 and 78 on the cards. The sample run documented in this report did not involve target shape data cards.

The direct fire program has been designed to permit certain calculations for a moving target or a moving firing tank. Single round hit probabilities and kill probabilities are obtainable for sets of up to 18 conditions. Input card requirements are then as explained in connection with Table 4.1, except for two differences. First, on the R1 card for only the first range involved in the run, INTPL does not have the previously explained meaning but should be set to 987. The second difference is that each R3 card is replaced by a set of 18 such cards. It is assumed that, from other sources, biases and overall standard deviations including contributions of lay and round-to-round errors are known. Thus, these overall standard deviations can be entered in SIGXB and SIGYB, redefined accordingly; redefinition of the biases XB, YB is not necessary. Tape or disc input requirements are not affected. Sections of the computer program that specifically apply to moving target or moving firing tank calculations were not exercised in the sample run made for this report.

TABLE 4.4 SAMPLE CARDS WITH TARGET SHAPE DATA

```
   88-  24-  24   88    8    8   84-  24-  24   84-   8-   8            1340 0 1
   84    8    8   84   24   24   80-  24-  20   80-   8-   8            1340 0 2
   80    8    8   80   24   24   76-  28-   8   76    8   12            1340 0 3
              E T C . . . . .
-  20-  36-  28-  20   28   36 9999 9999 9999                            1340 015
   88-   4-   4   88   20   24   84-   4-   4   84    8    8            134030 1
   84   24   36   80    0   20   80   28   44   80   52   52            134030 2
   76    0   48   76   64   64   72    4   64   68    4   60            134030 3
              E T C . . . . .
-  20   36   48 9999 9999 9999                                          13403014
   92   24   24   88   12   16   88   28   28   84   20   36            134060 1
              E T C . . . . .
```

33

```
          COLUMNS
            1         2         3         4         5         6         7  7       8
1234567890123456789012345678901234567890123456789012345678901234567890  34567890

   CARD 1340 0 1    NCTRY( 1,1),   NCTRXL( 1,1),  NCTRXR( 1,1),
                    NCTRY( 2,1),   NCTRXL( 2,1),  NCTRXR( 2,1),
                    NCTRY( 3,1),   NCTRXL( 3,1),  NCTRXR( 3,1),
                    NCTRY( 4,1),   NCTRXL( 4,1),  NCTRXR( 4,1)
   88-  24-  24   88    8    8   84-  24-  24   84-   8-   8            1340 0 1


   CARD 1340 0 2    NCTRY( 5,1),   NCTRXL( 5,1),  NCTRXR( 5,1),
                    NCTRY( 6,1),   NCTRXL( 6,1),  NCTRXR( 6,1),
                    NCTRY( 7,1),   NCTRXL( 7,1),  NCTRXR( 7,1),
                    NCTRY( 8,1),   NCTRXL( 8,1),  NCTRXR( 8,1)
   84    8    8   84   24   24   80-  24-  20   80-   8-   8            1340 0 2


   CARD 1340 0 3    NCTRY( 9,1),   NCTRXL( 9,1),  NCTRXR( 9,1),
                    NCTRY(10,1),   NCTRXL(10,1),  NCTRXR(10,1),
```

TABLE 4,4 SAMPLE CARDS WITH TARGET SHAPE DATA (CONTINUED)

```
                    NCTRY(11,1),   NCTRXL(11,1),  NCTRXR(11,1),
                    NCTRY(12,1),   NCTRXL(12,1),  NCTRXR(12,1)
80    8    8   80   24   24   76-  28-   8   76    8   12                1340 0 3

        E T C . . . . .

CARD 1340 015     NCTRY(57,1),   NCTRXL(57,1),  NCTRXR(57,1),
                  NCTRY(58,1),   NCTRXL(58,1),  NCTRXR(58,1),
                  NCTRY(59,1),   NCTRXL(59,1),  NCTRXR(59,1),
                  NCTRY(60,1),   NCTRXL(60,1),  NCTRXR(60,1)

20-  36-  28-  20   28   36 9999 9999 9999                               1340 015

CARD 134030 1     NCTRY( 1,2),   NCTRXL( 1,2),  NCTRXR( 1,2),
                  NCTRY( 2,2),   NCTRXL( 2,2),  NCTRXR( 2,2),
                  NCTRY( 3,2),   NCTRXL( 3,2),  NCTRXR( 3,2),
                  NCTRY( 4,2),   NCTRXL( 4,2),  NCTRXR( 4,2)
88-   4-   4   88   20   24   84-   4-   4   84    8    8                134030 1

CARD 134030 2     NCTRY( 5,2),   NCTRXL( 5,2),  NCTRXR( 5,2),
                  NCTRY( 6,2),   NCTRXL( 6,2),  NCTRXR( 6,2),
                  NCTRY( 7,2),   NCTRXL( 7,2),  NCTRXR( 7,2),
                  NCTRY( 8,2),   NCTRXL( 8,2),  NCTRXR( 8,2)
84   24   36   80   20   20   80   28   44   80   52   52                134030 2

CARD 134030 3     NCTRY( 9,2),   NCTRXL( 9,2),  NCTRXR( 9,2),
                  NCTRY(10,2),   NCTRXL(10,2),  NCTRXR(10,2),
                  NCTRY(11,2),   NCTRXL(11,2),  NCTRXR(11,2),
                  NCTRY(12,2),   NCTRXL(12,2),  NCTRXR(12,2)
76    0   48   76    6   64   72    4   64   68    4   60                134030 3

        E T C . . . . .
```

TABLE 4.4 SAMPLE CARDS WITH TARGET SHAPE DATA (CONTINUED)

```
CARD 13403014     NCTRY(53,2),   NCTRXL(53,2),  NCTRXR(53,2),
                  NCTRY(54,2),   NCTRXL(54,2),  NCTRXR(54,2),
                  NCTRY(55,2),   NCTRXL(55,2),  NCTRXR(55,2),
                  NCTRY(56,2),   NCTRXL(56,2),  NCTRXR(56,2)

20   36   48 9999 9999 9999                                        13403014

CARD 134060 1     NCTRY( 1,3),   NCTRXL( 1,3),  NCTRXR( 1,3),
                  NCTRY( 2,3),   NCTRXL( 2,3),  NCTRXR( 2,3),
                  NCTRY( 3,3),   NCTRXL( 3,3),  NCTRXR( 3,3),
                  NCTRY( 4,3),   NCTRXL( 4,3),  NCTRXR( 4,3)
92   24   24   88   12   16   88   28   28   84   20   36        134060 1

          E T C . . . . .
```

5. OUTPUT DATA

5.1 Introduction.

Output results provided by the direct fire program consist primarily of cumulative hit probabilities and kill probabilities for up to 15 rounds, average numbers of rounds expected to be needed to hit or kill targets, and cumulative hit probabilities and kill probabilities versus engagement time for up to 2 minutes. In addition, cumulative passenger casualties expected for up to 15 rounds are included for personnel carrier targets. Information useful for verifying the input data used also constitutes a part of the printed output.

5.2 Outputs of Sample Computer Run.

The input quantities identified in Table 4.1 (and Table 4.2) anc data from a vulnerability data tape were used to make a sample run. Table 5.1 presents selected results of this run.

All data from the input cards used for a run are rewritten exactly as they appear on the cards. The same data are generally repeated with corresponding program symbols and a brief indication of what the symbols mean. Exceptionally, quantities associated with the program symbols may not be strictly identical to the related card quantities. For example, the dimension of target cells may be in millimeters originally and converted to inches.

Identifying conditions associated with input information provided by the vulnerability data tape or disc are printed, but the actual vulnerability data are not.

The number of samples is not calculated but has been fixed in the program itself at 10,000.

Angles 1 and 2 designate target orientation directions of 0 and 180 degrees respectively. Data already identified as the primary output results of a run are printed for each such related pair of target orientations (angles 1 and 2, 3 and 4, etc.).

Cumulative hit probabilities and kill probabilities, as well as personnel casualties when applicable, for up to 15 rounds are arranged in twelve columns of 15 quantities each. Reading horizontally, one sees two sets of five columns followed by two columns. The first five columns correspond to the first angle (0 degrees for the first pair of angles) and are, from left to right, cumulative probabilities of achieving an M kill, an F kill, an M or F kill, a K kill, or a hit on the target. The next five columns contain this same information, similarly arranged, for the second angle (180 degrees for the first pair). The last two columns, printed only when they apply, are cumulative passenger casualties for the two angles (0 and 180 degrees) respectively.

TABLE 5.1 SAMPLE OUTPUT DATA

R159851340

```
  3   10  250    2    0    0   15    0    1    0    0    0    0    0
  0    0    0    0    0    0    0    0
```

NRSKP	VULN. TAPE FILES TO SKIP	3
NCASES	NO. OF CASES	10
NRFRST	FIRST RANGE FOR VULN. DATA	250
NTGT	VULN. TAPE FORMAT	2
NRDTYP	VULN. DATA DEP. ON RANGE	0
NRD1	SINGLE ROUND ENGAGEMENT	0
NRDS	MAX. NO. OF RDS.	15
NADJST	SP. PROC. FOR MISS. RD.	0
NRFBS	RANGEFINDER OR BATTLESIGHT	1
NDROP	STANDARD DROP ADJUSTMENT	0
NHIT	ADJ. HIT	0
NPRHIT	HIT PROB. OUTPUT ONLY	0
NDTRM1	DETERMINISTIC2 HIT1	0
NDTRM2	DET2 NO K KILL HIT1	0
NDTRM3	DET2 MISS1	0
NDTRM4	DET2 OBSERVED MISS1	0
NDTRM5	DET2 UNOBSERVED MISS1	0
NHTKLL	HIT AND KILL PROB. INPUT	0
NTCRD1	CARDS FOR TARGET1	0
NTCRD2	CARDS FOR TARGET2	0
NTCRD3	CARDS FOR TARGET3	0
NTCRD4	CARDS FOR TARGET4	0

```
  6.0000    4.0000    0.0000  -28.0000  -70.0000 9999.9999     .9900
   .9280
```

			HOR.	VERT.
PASSN	TGT. PERS. EXCL. CREW	6.0000		
W,W	CELL DIM. IN INCHES		4.0000	4.0000
XC,YC	TGT. CTR. COORD. INS.		0.0000	-28.0000
YBASE	TGT. BOT. COORD. INS.			-70.0000
YTOP	TOP APPR. COORD. INS.			9999.9999
RELT	PROB. OF REL. FLIGHT	.9900		
RELF	PROB. OF REL. FUZE	.9280		

TABLE 5.1 SAMPLE OUTPUT DATA (CONTINUED)

```
250     0     0

   1.7100     0.0000     0.0000    19.8000    15.6000     0.0000     0.0000
   0.0000     0.0000      .0357     1.0161     2.7038     5.5923      .2277
    .2277      .6136      .6872      .7800     1.4635     1.4635     0.0000
   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
   0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
   0.0000     0.0000
```

			TIME DATA (SECONDS) 1ST RD.	SUBS. RDS.
FLT	TIME OF FLIGHT	1.7100		
TF1,TFS	FIXED TIME		0.0000	0.0000
XM1,XM2	MEDIAN VARIABLE TIME		19.8000	15.6000
AMT1,AMT2	MINIMUM TIME		0.0000	0.0000
STD1,STD2	VARIABILITY FACTOR		0.0000	0.0000

			ACCURACY DATA (METERS) HOR.	VERT.
XB,YB	FIXED BIAS		.0357	1.0161
SIGXB,SIGYB	VAR. BIAS STD. DEV.		2.7038	5.5923
SIGXL,SIGYL	LAY ERROR STD. DEV.		.2277	.2277
SIGXR,SIGYR	RD.-TO-RD.STD. DEV.		.6136	.6872
PROBS	PROB. SENS. MISS. RD.	.7800		
SIGXS,SIGYS	SENS. ERROR STD. DEV.		1.4635	1.4635

PROJECTILE 985 VS. VEHICLE 1340 087

TASK SHEET IDENTIFICATION	R15
PROJECTILE CODE	985
TARGET CODE	1340
RANGE IN METERS	250

0 DEG ELEV, 0 DEG AZIM						0 DEG ELEV, 180 DEG AZIM				
X	Y	M	F	M/F	K	EC	M	F	M/F	K	EC

0 DEG ELEV, 30 DEG AZIM						0 DEG ELEV, 150 DEG AZIM				
X	Y	M	F	M/F	K	EC	M	F	M/F	K	EC

0 DEG ELEV, 60 DEG AZIM						0 DEG ELEV, 120 DEG AZIM				
X	Y	M	F	M/F	K	EC	M	F	M/F	K	EC

TABLE 5.1 SAMPLE OUTPUT DATA (CONTINUED)

		0 DEG ELEV, 90 DEG AZIM					0 DEG ELEV, 270 DEG AZIM				
X	Y	M	F	M/F	K	EC	M	F	M/F	K	EC

NUMBER OF SAMPLES = 10000

ANGLES = 1 2

NRDS	PROB. (EXP. CAS.)				
1	.0310000	.0300000	.0310000	.0212000	.0352000
2	.1578000	.1529000	.1585000	.1060000	.1762000
3	.2747000	.2677000	.2754000	.1969000	.3043000
4	.3877000	.3763000	.3882000	.2884000	.4238000
5	.4793000	.4681000	.4796000	.3695000	.5178000
6	.5568000	.5450000	.5571000	.4407000	.5951000
7	.6249000	.6131000	.6255000	.5057000	.6646000
8	.6790000	.6683000	.6798000	.5600000	.7178000
9	.7284000	.7178000	.7292000	.6114000	.7655000
10	.7667000	.7566000	.7674000	.6515000	.8028000
11	.8001000	.7900000	.8008000	.6888000	.8348000
12	.8315000	.8217000	.8320000	.7246000	.8625000
13	.8578000	.8494000	.8582000	.7598000	.8859000
14	.8787000	.8715000	.8792000	.7879000	.9036000
15	.8978000	.8916000	.8983000	.8124000	.9199000
1	.0299000	.0289000	.0299000	.0215000	.0368000
2	.1499000	.1429000	.1499000	.1057000	.1762000
3	.2701000	.2601000	.2701000	.1972000	.3101000
4	.3703000	.3581000	.3703000	.2785000	.4222000
5	.4575000	.4447000	.4576000	.3508000	.5145000
6	.5344000	.5194000	.5348000	.4215000	.5913000
7	.5982000	.5838000	.5987000	.4826000	.6565000
8	.6579000	.6431000	.6582000	.5387000	.7137000
9	.7050000	.6903000	.7053000	.5864000	.7576000
10	.7473000	.7331000	.7474000	.6313000	.7979000
11	.7826000	.7694000	.7827000	.6691000	.8312000
12	.8143000	.8028000	.8144000	.7039000	.8602000
13	.8402000	.8287000	.8403000	.7356000	.8826000
14	.8646000	.8539000	.8647000	.7673000	.9027000
15	.8826000	.8716000	.8827000	.7903000	.9191000
1	.0828622	.0928149			
2	.4197333	.4444624			
3	.7544151	.8158528			
4	1.0759812	1.1396685			
5	1.3500448	1.4204448			
6	1.5879577	1.6770897			
7	1.8020048	1.8936590			
8	1.9762646	2.0894381			
9	2.1348499	2.2512219			
10	2.2621322	2.3986733			
11	2.3776576	2.5282113			
12	2.4867633	2.6408755			
13	2.5822915	2.7402884			

TABLE 5.1 SAMPLE OUTPUT DATA (CONTINUED)

14	2.6566855	2.8284182
15	2.7242920	2.8998553

AVG. NO. OF RDS.

1	7.62
2	7.80
3	7.61
4	9.91
5	7.00
6	8.00
7	8.28
8	8.00
9	10.48
10	7.03

PROBABILITY VERSUS TIME

0.00000 0.00000 0.00000 0.00000 .00050 .00150 .00250 .00630 .00880 .01280
.01730 .02320 .02820 .03500 .04290 .05290 .06290 .07420 .08430 .0965C
.10700 .11730 .12940 .14250 .15470 .16940 .18300 .19420 .20820 .2202C
.23260 .24510 .25840 .27030 .28290 .29720 .31110 .32260 .33390 .3445C
.35540 .36590 .37790 .39030 .40020 .41080 .42180 .43100 .44080 .4511C
.46000 .47050 .47990 .48920 .49940 .50900 .51750 .52550 .53400 .5426C
.55140

0.00000 0.00000 0.00000 0.00000 .00050 .00150 .00240 .00620 .00870 .0126C
.01700 .02270 .02760 .03440 .04190 .05180 .06140 .07240 .08220 .0941C
.10430 .11390 .12540 .13810 .15010 .16460 .17740 .18860 .20230 .2136C
.22600 .23820 .25090 .26310 .27550 .28960 .30320 .31410 .32540 .3357C
.34600 .35670 .36820 .38050 .39000 .40030 .41070 .41980 .42950 .4393C
.44800 .45830 .46750 .47680 .48690 .49660 .50520 .51390 .52290 .5316C
.54050

0.00000 0.00000 0.00000 0.00000 .00050 .00150 .00250 .00630 .00880 .0128C
.01730 .02320 .02820 .03500 .04310 .05310 .06310 .07440 .08450 .0968C
.10750 .11770 .12990 .14300 .15530 .17010 .18370 .19480 .20880 .2207C
.23310 .24560 .25890 .27080 .28340 .29770 .31150 .32290 .33420 .3447C
.35560 .36610 .37810 .39050 .40040 .41100 .42200 .43140 .44120 .4515C
.46040 .47090 .48030 .48960 .49980 .50920 .51790 .52600 .53450 .5432C
.55220

0.00000 0.00000 0.00000 0.00000 .00030 .00090 .00170 .00430 .00610 .0086C
.01180 .01560 .01960 .02410 .02920 .03550 .04240 .05050 .05750 .0662C
.07340 .08030 .08780 .09690 .10670 .11740 .12650 .13500 .14570 .1545C
.16410 .17360 .18510 .19490 .20570 .21700 .22820 .23880 .24730 .2565C
.26650 .27550 .28570 .29670 .30550 .31370 .32300 .33110 .34040 .3494C
.35710 .36700 .37560 .38270 .39210 .40130 .40900 .41760 .42660 .4334C
.44050

0.00000 0.00000 0.00000 0.00000 .00050 .00160 .00270 .00700 .01000 .0146C
.01930 .02560 .03150 .03870 .04800 .05930 .07070 .08330 .09540 .1090C
.12150 .13240 .14530 .15980 .17320 .18990 .20440 .21680 .23120 .2441C
.25710 .27050 .28400 .29790 .31110 .32680 .34120 .35340 .36570 .3768C
.38800 .39990 .41220 .42480 .43500 .44570 .45780 .46810 .47780 .4884C
.49720 .50800 .51770 .52680 .53650 .54590 .55510 .56320 .57210 .5810C
.58990

0.00000 0.00000 0.00000 .00010 .00030 .00110 .00220 .00470 .00740 .0098C

TABLE 5.1 SAMPLE OUTPUT DATA (CONTINUED)

```
 .01390  .01920  .02660  .03320  .04170  .05010  .06110  .07220  .08250  .09640
 .10670  .11650  .13000  .14090  .15260  .16360  .17480  .18730  .20130  .21280
 .22430  .23760  .24870  .26090  .27360  .28650  .29900  .31060  .32160  .33400
 .34450  .35500  .36580  .37610  .38480  .39500  .40670  .41690  .42640  .43560
 .44420  .45290  .46170  .47050  .47990  .48900  .49690  .50610  .51360  .52190
 .53010

0.00000 0.00000 0.00000  .00010  .00030  .00110  .00220  .00440  .00710  .00940
 .01340  .01840  .02560  .03170  .03980  .04790  .05860  .06940  .07950  .09260
 .10220  .11160  .12440  .13460  .14580  .15670  .16780  .17950  .19290  .20470
 .21530  .22850  .23940  .25110  .26340  .27590  .28720  .29820  .30910  .32140
 .33200  .34240  .35340  .36360  .37240  .38310  .39430  .40450  .41370  .42310
 .43200  .44100  .44990  .45770  .46710  .47610  .48410  .49310  .50050  .50870
 .51750

0.00000 0.00000 0.00000  .00010  .00030  .00110  .00220  .00470  .00740  .00980
 .01390  .01920  .02660  .03320  .04170  .05010  .06110  .07220  .08250  .09640
 .10670  .11650  .13000  .14090  .15260  .16360  .17480  .18730  .20130  .21280
 .22430  .23760  .24870  .26090  .27360  .28650  .29900  .31060  .32160  .33400
 .34460  .35510  .36590  .37620  .38490  .39510  .40680  .41700  .42650  .43570
 .44440  .45310  .46190  .47070  .48020  .48930  .49720  .50640  .51390  .52220
 .53040

0.00000 0.00000 0.00000  .00010  .00020  .00100  .00200  .00370  .00590  .00720
 .01000  .01400  .01960  .02450  .03070  .03620  .04320  .05160  .05970  .06890
 .07660  .08350  .09290  .10180  .10900  .11710  .12620  .13570  .14570  .15530
 .16360  .17590  .18390  .19300  .20200  .21110  .22050  .22960  .23750  .24740
 .25710  .26660  .27650  .28510  .29190  .30120  .31110  .32020  .32820  .33560
 .34400  .35230  .36040  .36780  .37470  .38230  .39100  .39910  .40670  .41440
 .42200

0.00000 0.00000 0.00000  .00010  .00040  .00130  .00280  .00560  .00920  .01250
 .01730  .02430  .03270  .04040  .05000  .05980  .07240  .08530  .09720  .11330
 .12530  .13680  .15200  .16510  .17790  .19050  .20340  .21680  .23260  .24540
 .25920  .27330  .28620  .29970  .31360  .32670  .34030  .35250  .36460  .37870
 .39020  .40150  .41400  .42510  .43420  .44450  .45780  .46840  .47820  .48760
 .49690  .50600  .51550  .52440  .53430  .54370  .55060  .56050  .56940  .57740
 .58580
```

ETC. . . . FOR OTHER ANGLES

Average numbers of rounds expected to be needed to hit or kill targets consist of two sets of five numbers each. The two sets correspond to the two target orientations respectively. The ordering within each set, according to the type of kill or whether only a target hit is considered, is the same as for the ten groups of hit probabilities and kill probabilities discussed in the preceding paragraph.

Ten groups of cumulative hit probabilities and kill probabilities versus engagement time follow. Five groups apply, as before, to each target orientation. The correspondence with kill type or whether only a target hit is of concern also remains as before. Each group contains 61 numbers. These are cumulative probabilities for engagement times of 0, 2, 4, etc., 118, 120 seconds.

It is recognized that the formats used to print output probabilities and expected personnel casualties contain several unnecessary decimal places. However, all results have been consistently rounded to two decimal places for the tank effectiveness pamphlets published by the JMEM-SS Methodology and Evaluations Working Group.

The choice of 10,000 samples that was made results in the computed output quantities, mostly probabilities, being practically always accurate to within 0.005. This degree of accuracy is basically equivalent to that achievable by deterministic programs.

6. COMPUTER ASPECTS

The direct fire program is coded in FORTRAN IV.

Production runs have been made, with the program, on the CDC 7600 computer at Aberdeen Proving Ground, Maryland and the CDC 6600 computer at Oklahoma State University Field Office, Eglin Air Force Base, Florida. Also, it has recently been learned that the Oklahoma State University Field Office will use a newer CYBER 176 computer for future production runs.

Running times can vary according to various factors, e.g., the computer used and the program options exercised. A basic run, i.e., one primarily intended to simulate 10,000 engagements for several target ranges and four pairs of target orientation angles at each range, would typically require about 1 minute of computer time for each range on either the CDC 7600 or CYBER 176.

APPENDIX A

PROGRAM LISTING AND DETAILED EXPLANATIONS

PROGRAM LISTING AND DETAILED EXPLANATIONS

The principal objective of this appendix is to provide a listing of FORTRAN statements and detailed explanations for the main program. For completeness, however, subroutine NRAN and function CNORM are also listed and briefly described.

Both the listing of program statements and the corresponding detailed explanations cover several pages. Listing and explanation pages have been intermixed so that program statements and accompanying explanations are reasonably near together.

Some input quantities have already been sufficiently explained in Section 4. Additional explanations related to inputs are included only as necessary to supplement that section.

Main program lines are numbered from 1 through 1385. These lines were grouped as seemed most convenient to facilitate the explanations.

Certain program statements require no explanation. Other statements, used more than once, are covered only when they first occur.

The listing and explanations for the main program, subroutine NRAN, and function CNORM follow.

```
      PROGRAM MEWGD ( INPUT, OUTPUT, TAPE5=INPUT, TAPE6=OUTPUT, TAPE2 )
C
      COMMON A(80)          ,AFAIL(15)      ,AKIL(61,10)    ,AX(201)
     A      ,AY(51)         ,C(10)          ,IDCODE(10)     ,IK(50,200)
     B      ,IP(10)         ,ITAPE(80)      ,MPK(3000,8)    ,NXTEMP(4)
     C      ,NYTEMP(4)      ,PK(10)         ,PKRLFT(10)     ,XTEMPL(4)
     D      ,XTEMPH(4)      ,IMODXY(3000,4),YTEMPL(4)       ,Z(19,12)
     E      ,XLEFTF(4)      ,XRGHTF(4)      ,XLEFTD(4)      ,XRGHTD(4)
      COMMON KDMSTC(5)      ,BX(5)          ,BY(5)          ,SIGX(3,5)
     A      ,SIGY(3,5)      ,NMINUS(50,2,5),NPLUS(50,2,5) ,COORD(2)
     B      ,TOTAL(2)       ,NPOS(50)       ,NNEG(50)       ,NCMPOS(50)
     C      ,NCMNEG(50)     ,NRFLCT(50)     ,BIASXY(2,5)    ,SIGMXY(3,2,5)
     D      ,PH(3,5)        ,PKILL(4,3,5)
      COMMON BBX(4)         ,BBY(4)         ,SSIGX(4)       ,SSIGY(4)
     A      ,PPH(5)         ,PKSHOT(4,5)    ,PPKHIT(4,5)
      COMMON KTRGTC(4)      ,NCTRY(120,4)   ,NCTRXL(120,4) ,NCTRXR(120,4)
      COMMON XXB(3,6),YYB(3,6),SSIGXB(3,6),SSIGYB(3,6)
      DATA   MASK11   /   3777 B   /
      DATA   MASK16   /   177777 B   /
      WRITE ( 6,1010 )
 1010 FORMAT ( / / )
      READ  ( 5,1110 ) IDCODE
 1110 FORMAT ( 10A1 )
      WRITE ( 6,1112 ) IDCODE
 1112 FORMAT ( 1H1, 10X,10A1 )
      WRITE ( 6,1010 )
      READ  ( 5,1120 ) NRSKP ,NCASES,NRFRST,NTGT  ,NRDTYP,NRD1  ,NRDS
     A                ,NADJST,NRFBS ,NDROP ,NHIT  ,NPRHIT,NDTRM1,NDTRM2
     B                ,NDTRM3,NDTRM4,NDTRM5,NHTKLL,NTCRD1,NTCRD2,NTCRD3
     C                ,NTCRD4
 1120 FORMAT ( 14I5 )
      WRITE ( 6,1122 ) NRSKP ,NCASES,NRFRST,NTGT  ,NRDTYP,NRD1  ,NRDS
     A                ,NADJST,NRFBS ,NDROP ,NHIT  ,NPRHIT,NDTRM1,NDTRM2
     B                ,NDTRM3,NDTRM4,NDTRM5,NHTKLL,NTCRD1,NTCRD2,NTCRD3
     C                ,NTCRD4
 1122 FORMAT ( 10X,14I5 )
      WRITE ( 6,1020 )
 1020 FORMAT ( )
      IF ( NRSKP .EQ. 9999 ) NRSKP = 0
      WRITE ( 6,1130 ) NRSKP ,NCASES,NRFRST,NTGT  ,NRDTYP,NRD1  ,NRDS
     A                ,NADJST,NRFBS ,NDROP ,NHIT  ,NPRHIT,NDTRM1,NDTRM2
      WRITE ( 6,1131 ) NDTRM3,NDTRM4,NDTRM5,NHTKLL,NTCRD1,NTCRD2,NTCRD3
     A                ,NTCRD4
 1130 FORMAT ( 10X,39H NRSKP          VULN. TAPE FILES TO SKIP,9X,I5  /
     A          10X,27H NCASES        NO. OF CASES,21X,I5  /
     B          10X,41H NRFRST        FIRST RANGE FOR VULN. DATA,7X,I5  /
     C          10X,32H NTGT          VULN. TAPE FORMAT,16X,I5  /
     D          10X,39H NRDTYP        VULN. DATA DEP. ON RANGE,9X,I5  /
     E          10X,38H NRD1          SINGLE ROUND ENGAGEMENT,10X,I5  /
     F          10X,31H NRDS          MAX. NO. OF RDS.,17X,I5  /
     G          10X,38H NADJST        SP. PROC. FOR MISS. RD.,10X,I5  /
     H          10X,41H NRFBS         RANGEFINDER OR BATTLESIGHT,7X,I5  /
     J          10X,39H NDROP         STANDARD DROP ADJUSTMENT,9X,I5  /
     K          10X,23H NHIT          ADJ. HIT,25X,I5  /
     L          10X,36H NPRHIT        HIT PROB. OUTPUT ONLY,12X,I5  /
     M          10X,34H NDTRM1        DETERMINISTIC2 HIT1,14X,I5  /
     N          10X,34H NDTRM2        DET2 NO K KILL HIT1,14X,I5  )
```

EXPLANATIONS

REFERENCES TO THE LEFT OF EXPLANATIONS ARE TO PROGRAM LINE NUMBERS

1	TAPE 5 IS ASSOCIATED WITH INPUT CARDS AND TAPE 2 WITH TAPE OR DISC CONTAINING TARGET VULNERABILITY INPUT DATA.
3– 17	THESE ARE REALLY DIMENSION STATEMENTS. OKLAHOMA STATE UNIVERSITY FIELD OFFICE AT EGLIN AIR FORCE BASE HAS FOUND THAT SYSTEMATIC USE OF COMMON STATEMENTS ENHANCES COMPUTER EFFICIENCY.
18– 19	THESE DATA STATEMENTS ARE RELATED TO RETRIEVAL OF KILL PROBABILITY AND PERSONNEL CASUALTY INFORMATION FROM FILES CONTAINING SUCH INFORMATION IN PACKED FORM.
20– 165	PORTION OF PROGRAM PRECEDING PROCESSING FOR ANY PARTICULAR RANGE.
20– 21	SKIP 3 LINES.
22– 25	READ AND WRITE INPUT CARD 1.
27– 36	READ AND WRITE INPUT CARDS 2 AND 3.
37– 38	SKIP 1 LINE.
39	NRSKP = 9999 HAS BEEN TEMPORARILY PUNCHED ON INPUT CARDS AS CONSPICUOUS ALERT THAT PROPER ENTRY NEEDS TO BE DETERMINED LATER. THIS IS SIMPLY MATTER OF CONVENIENCE. TEMPORARY VALUE 9999 CAN BE RETAINED AS INPUT IF 0 PROVES TO BE CORRECT ENTRY, BECAUSE OF RESETTING DONE HERE.
40– 65	REWRITE INPUTS ON CARDS 2 AND 3 WITH ABBREVIATED INDICATION OF WHAT EACH NUMBER REPRESENTS.
66– 69	IF NRD1 = 1, NRDS IS IGNORED AND NOT USED. OTHERWISE, MAXIMUM NUMBER OF ROUNDS TO BE FIRED PER ENGAGEMENT, READ AS INPUT, MAY BE OVERRIDDEN EITHER BY LOWER OR UPPER BOUND. REASON FOR LOWER BOUND OF 10 ROUNDS IS INDICATED IN CONNECTION WITH PROGRAM LINES 1333 THROUGH 1340. UPPER BOUND OF 19 ROUNDS HAS BEEN ARBITRARILY SELECTED SIMPLY TO LIMIT SCOPE OF PROGRAM CALCULATIONS. RDS IS REAL FORM.
71– 77	IF AT LEAST ONE OF CONTROLS NDTRM1 THROUGH NDTRM5 IS NOT 0, THEIR SUM NSMDTR IS ALSO NOT 0 AND ALL FIVE QUANTITIES ARE ENTERED IN ARRAY KDMSTC.
78– 85	IF AT LEAST ONE OF CONTROLS NTCRD1 THROUGH NTCRD4 IS NOT 0, THEIR SUM NSTCRD IS ALSO NOT 0, ALL FOUR QUANTITIES ARE ENTERED IN ARRAY KTRGTC, AND PROGRAM LINES 86 THROUGH 95 ARE SKIPPED BECAUSE TAPE OR DISC WITH VULNERABILITY DATA IS NOT INVOLVED.
87– 95	SKIP FILES AS NECESSARY ON VULNERABILITY DATA TAPE OR DISC. NSKP FILES SKIPPED ARE NRSKP FILES NOT APPLYING TO ROUND/TARGET COMBINATION OF CONCERN AND POSSIBLY ADDITIONAL FILES ASSOCIATED WITH RANGES LESS THAN FIRST ONE TO BE CONSIDERED. STATEMENT INVOLVING GOING TO 311 IF EOF(IU)=1.0 PREVENTS MINOR INCONSISTENCIES IN FILE MARK LOCATION THAT ARE OCCASIONALLY ENCOUNTERED FROM

```
 1131 FORMAT ( 10X,25H NDTRM3          DET2 MISS1,23X,I5  /
     A         10X,34H NDTRM4          DET2 OBSERVED MISS1,14X,I5  /
     B         10X,36H NDTRM5          DET2 UNOBSERVED MISS1,12X,I5  /
     C         10X,39H NHTKLL          HIT AND KILL PROB. INPUT,9X,I5  /
     D         10X,32H NTCRD1          CARDS FOR TARGET1,16X,I5  /
     E         10X,32H NTCRD2          CARDS FOR TARGET2,16X,I5  /
     F         10X,32H NTCRD3          CARDS FOR TARGET3,16X,I5  /
     G         10X,32H NTCRD4          CARDS FOR TARGET4,16X,I5  )
      IF ( NRD1 .EQ. 1 ) GO TO 1132
      IF ( NRDS .LT. 10 ) NRDS = 10
      IF ( NRDS .GT. 19 ) NRDS = 19
      RDS = NRDS
 1132 CONTINUE
      NSMDTR = NDTRM1 + NDTRM2 + NDTPM3 + NDTRM4 + NDTRM5
      IF ( NSMDTR .EQ. 0 ) GO TO 1135
      KDMSTC(1) = NDTRM1
      KDMSTC(2) = NDTRM2
      KDMSTC(3) = NDTRM3
      KDMSTC(4) = NDTRM4
      KDMSTC(5) = NDTRM5
 1135 CONTINUE
      NSTCRD = NTCRD1 + NTCRD2 + NTCRD3 + NTCRD4
      IF ( NSTCRD .EQ. 0 ) GO TO 1145
      KTRGTC(1) = NTCRD1
      KTRGTC(2) = NTCRD2
      KTRGTC(3) = NTCRD3
      KTRGTC(4) = NTCRD4
      GO TO 1200
 1145 CONTINUE
      REWIND 2
      IU = 2
      NSKP = NRSKP
      IF ( NRDTYP .EQ. 1 ) NSKP = NSKP + NRFRST/500
      IF ( NSKP .EQ. 0 ) GO TO 1200
      CALL SKIPFE (IU,NSKP,0)
      READ ( IU,3110 ) A
      IF ( EOF(IU) .EQ. 1.0 ) GO TO 311
  311 CONTINUE
 1200 CONTINUE
      WRITE ( 6,1010 )
      READ  ( 5,1210 ) PASSN ,WCELL ,XC     ,YC     ,YBASE ,YTOP  ,RELT
     A                 ,RELF
 1210 FORMAT ( 7F10.4 )
      WRITE ( 6,1212 ) PASSN ,WCELL ,XC     ,YC     ,YBASE ,YTOP  ,RELT
     A                 ,RELF
 1212 FORMAT ( 10X,7F10.4 )
      WRITE ( 6,1020 )
      W = WCELL
      IF ( WCELL .EQ. 4.0 ) GO TO 1215
      W = W / 25.4
      XC = XC / 25.4
      YC = YC / 25.4
      YBASE = YBASE / 25.4
      IF ( YTOP .LT. 9999.0 ) YTOP = YTOP / 25.4
 1215 CONTINUE
      WRITE ( 6,1220 )
 1220 FORMAT ( 65X,16H HOR.      VERT. )
```

STOPPING RUN.

98- 103 READ AND WRITE INPUT CARDS 4 AND 5.

105- 111 W IS NEEDED BECAUSE WCELL NEEDS TO BE PRESERVED AS READ FROM INPUT CARD. IF WCELL = 100.0, W, XC, YC, YBASE, AND POSSIBLY YTOP ARE ALL CONVERTED FROM MILLIMETERS TO INCHES. YTOP = 9999.0 OR ANY LARGER NUMBER INDICATES YTOP IS UNNEEDED AND TO BE IGNORED.

113- 124 REWRITE INPUTS ON CARDS 4 AND 5 WITH ABBREVIATED INDICATION OF WHAT EACH NUMBER REPRESENTS.

125 H IS HALF OF W AND CONSEQUENTLY REPRESENTS PERPENDICULAR DISTANCE FROM CENTER OF ANY TARGET CELL TO SIDES.

126- 127 VERTICAL COORDINATE YAIM OF INTENDED AIMPOINT CAN CORRESPOND EITHER TO APPROXIMATE CENTER OF MASS OR TO BASE OF TARGET.

128- 134 VALUES 2, 3, 4, AND 5 FOR NADJST HAVE BEEN USED TO DATE ONLY IN CONNECTION WITH SPECIAL STUDY NADE FOR US ARMY ARMOR SCHOOL, FORT KNOX IN 1978. REQUIREMENTS OF THAT EFFORT ARE NOT OF GENERAL INTEREST AND NEED NOT BE DISCUSSED IN DETAIL IN THIS REPORT. SINCE 5 IS LARGEST VALUE USED TO DATE FOR NADJST, CONSIDERATION IS RESTRICTED TO NADJST EQUALLING 0 OR 1 IN REMAINDER OF THESE EXPLANATIONS.

136- 158 NSTCRD IS NORMALLY 0 BECAUSE MOST RUNS INVOLVE TAPE OR DISC CONTAINING TARGET VULNERABILITY DATA. EXCEPTIONALLY, INPUT CARDS CONTAINING TARGET SHAPE DATA NEED TO BE READ. IF NSTCRD IS NOT 0, AT LEAST ONE OF CONTROL QUANTITIES IN KTRGTC ARRAY MUST ALSO DIFFER FROM 0. ITGT VALUES 1, 2, 3, AND 4 CORRESPOND TO TARGET ORIENTATION ANGLES OF 0, 30, 60, AND 90 DEGREES RESPECTIVELY. ALL COORDINATES ARE IN SAME UNIT AS WCELL. VERTICAL COORDINATE OF CELL CENTERS FOR EACH HORIZONTAL STRIP OF TARGET CELLS IS ENTERED IN NCTRY ARRAY. HORIZONTAL COORDINATES OF CENTERS OF CELLS AT LEFT AND RIGHT ENDS OF STRIP ARE STORED IN NCTRXL AND NCTRXR ARRAYS. LAST COORDINATE IN EACH SET IS IDENTIFIED BY USE OF 9999 AS NEXT ENTRY.

160- 165 INITIAL SETTINGS.

166-1382 CYCLE FOR EACH RANGE CONSIDERED.

166 EXCEPT WHEN SET TO INITIAL INTPL SETTING, CONTROL QUANTITY JNTPL PRESERVES VALUE OF INTPL USED IN CALCULATION CYCLE FOR PREVIOUS RANGE WHEN RANGE INTERPOLATION OF TARGET VULNERABILITY DATA MAY HAVE BEEN INVOLVED. INPUT VALUE 987 FOR INTPL IS SPECIAL SETTING ENTERED ONLY ON INPUT CARD R1 FOR FIRST RANGE CONSIDERED IN RUN WHEN MOVING TARGET OR MOVING FIRING WEAPON IS INVOLVED.

167- 168 BEGIN PRINTING FOR EACH RANGE ON NEW PAGE.

169- 170 READ AND WRITE INPUT CARD R1.

171- 172 CONTROL QUANTITY ISTMOV IS SET TO 1 AND COUNTER MSET IS GIVEN INITIAL SETTING IF RUN INVOLVES MOVING TARGET OR MOVING FIRING WEAPON.

174 PROGRAM LINES 175 THROUGH 255 ARE NORMALLY APPLICABLE BUT ARE SKIPPED FOR MOVING TARGET OR MOVING FIRING WEAPON RUN.

175- 245 READ AND WRITE INPUT CARDS R2 THROUGH R8. REWRITE INPUTS ON THESE CARDS WITH INDICATION OF WHAT EACH NUMBER REPRESENTS. OPTW AND NHTKLL CONTROL REWRITING OR SKIPPING OF SEVERAL QUANTITIES THAT ARE OFTEN UNNEEDED FOR RUN AND SET TO 0 (OR LEFT BLANK) ON INPUT CARDS.

```
115                WRITE ( 6,1020 )
                   WRITE ( 6,1230 ) PASSN ,W     ,W     ,XC    ,YC    ,YBASE ,YTOP
                  A                 ,RELT  ,RELF
               1230 FORMAT ( 10X,36H PASSN          TGT. PERS. EXCL. CREW,7X,F10.4  /
                  A          10X,34H W,W           CELL DIM. IN INCHES,19X,2F10.4  /
120               B          10X,36H XC,YC         TGT. CTR. COORD. INS.,17X,2F10.4  /
                  C          10X,36H YBASE         TGT. BOT. COORD. INS.,27X,F10.4  /
                  D          10X,36H YTOP          TOP APPR. COORD. INS.,27X,F10.4  /
                  E          10X,35H RELT          PROB. OF REL. FLIGHT,8X,F10.4  /
                  F          10X,33H RELF          PROB. OF REL. FUZE,10X,F10.4  )
125                H = W / 2.0
                   YAIM = YC
                   IF ( NRFBS .EQ. 2 ) YAIM = YBASE
                   IF ( NADJST .LT. 2 .OR. NADJST .GT. 5 ) GO TO 1300
                   XLEFTF(1) = -1650.0 / 25.4
130                XLEFTF(4) = -3050.0 / 25.4
                   XLEFTD(1) = -1350.0 / 25.4
                   XRGHTF(1) = 1650.0 / 25.4
                   XRGHTF(4) = 3550.0 / 25.4
                   XRGHTD(1) = 1450.0 / 25.4
135             1300 CONTINUE
                   IF ( NSTCRD .EQ. 0 ) GO TO 2000
                   WRITE ( 6,1010 )
                   DO 1310 ITGT = 1,4
                   IF ( KTRGTC(ITGT) .EQ. 0 ) GO TO 2000
140                WRITE ( 6,1020 )
                   DO 1320 J = 1,30
                   K = 4 * (J-1)
                   READ  ( 5,1330 ) NCTRY(K+1,ITGT),NCTRXL(K+1,ITGT),NCTRXR(K+1,ITGT)
                  A                 ,NCTRY(K+2,ITGT),NCTRXL(K+2,ITGT),NCTRXR(K+2,ITGT)
145               B                 ,NCTRY(K+3,ITGT),NCTRXL(K+3,ITGT),NCTRXR(K+3,ITGT)
                  C                 ,NCTRY(K+4,ITGT),NCTRXL(K+4,ITGT),NCTRXR(K+4,ITGT)
               1330 FORMAT ( 12I5 )
                   WRITE ( 6,1332 ) NCTRY(K+1,ITGT),NCTRXL(K+1,ITGT),NCTRXR(K+1,ITGT)
                  A                 ,NCTRY(K+2,ITGT),NCTRXL(K+2,ITGT),NCTRXR(K+2,ITGT)
150               B                 ,NCTRY(K+3,ITGT),NCTRXL(K+3,ITGT),NCTRXR(K+3,ITGT)
                  C                 ,NCTRY(K+4,ITGT),NCTRXL(K+4,ITGT),NCTRXR(K+4,ITGT)
               1332 FORMAT ( 10X,12I5 )
                   IF ( NCTRY(K+1,ITGT) .EQ. 9999 .OR.
                  A     NCTRY(K+2,ITGT) .EQ. 9999 .OR.
155               B     NCTRY(K+3,ITGT) .EQ. 9999 .OR.
                  C     NCTRY(K+4,ITGT) .EQ. 9999 ) GO TO 1310
               1320 CONTINUE
               1310 CONTINUE
               2000 CONTINUE
160                NRANGE = 1
                   NEJECT = 0
                   JNTPL = 0
                   INTPL = 0
                   ISPLIT = 0
165                ISTMOV = 0
               2010 IF ( NRDTYP .EQ. 1 .AND. INTPL .NE. 987 ) JNTPL = INTPL
                   WRITE ( 6,2020 )
               2020 FORMAT ( 1H1 )
                   READ  ( 5,1120 ) IRANGE,INTPL,IMILS
170                WRITE ( 6,1122 ) IRANGE,INTPL,IMILS
                   IF ( NRANGE .EQ. 1 .AND. INTPL .EQ. 987 ) ISTMOV = 1
```

```
      IF ( ISTMOV .EQ. 1 ) MSET = 1
      WRITE ( 6,1010 )
      IF ( ISTMOV .EQ. 1 ) GO TO 2200
175   READ  ( 5,1210 ) FLT   ,TF1   ,TFS   ,XM1   ,XM2   ,AMT1  ,AMT2
     A                 ,STD1  ,STD2  ,XB    ,YB    ,SIGXB ,SIGYB ,SIGXL
     B                 ,SIGYL ,SIGXR ,SIGYR ,PROBS ,SIGXS ,SIGYS ,PGH
     C                 ,PGS   ,PGCH  ,PGCS  ,SGHX  ,SGHY  ,SGSX  ,SGSY
     D                 ,CDRX  ,CDRY  ,HSX   ,HSY   ,XBH   ,YBH   ,SIGXBH
180  E                 ,SIGYBH,XBL   ,YBL   ,SIGXBL,SIGYBL,XBS   ,YBS
     F                 ,SIGXBS,SIGYBS
      WRITE ( 6,1212 ) FLT   ,TF1   ,TFS   ,XM1   ,XM2   ,AMT1  ,AMT2
     A                 ,STD1  ,STD2  ,XB    ,YB    ,SIGXB ,SIGYB ,SIGXL
     B                 ,SIGYL ,SIGXR ,SIGYR ,PROBS ,SIGXS ,SIGYS ,PGH
185  C                 ,PGS   ,PGCH  ,PGCS  ,SGHX  ,SGHY  ,SGSX  ,SGSY
     D                 ,CDRX  ,CDRY  ,HSX   ,HSY   ,XBH   ,YBH   ,SIGXBH
     E                 ,SIGYBH,XBL   ,YBL   ,SIGXBL,SIGYBL,XBS   ,YBS
     F                 ,SIGXBS,SIGYBS
      WRITE ( 6,1010 )
190   WRITE ( 6,2110 )
2110 FORMAT (     63X,20H TIME DATA (SECONDS),
     A         /   64X,19H 1ST RD. SUBS. RDS.  )
      WRITE ( 6,1020 )
      WRITE ( 6,2120 ) FLT   ,TF1   ,TFS   ,XM1   ,XM2   ,AMT1  ,AMT2
195  A                 ,STD1  ,STD2
2120 FORMAT ( 10X,29H FLT           TIME OF FLIGHT,14X,F10.4  /
     A         10X,25H TF1,TFS      FIXED TIME,28X,2F10.4  /
     B         10X,35H XM1,XM2      MEDIAN VARIABLE TIME,18X,2F10.4  /
     C         10X,27H AMT1,AMT2    MINIMUM TIME,26X,2F10.4  /
200  D         10X,33H STD1,STD2    VARIABILITY FACTOR,20X,2F10.4  )
      WRITE ( 6,1020 )
      IF ( IMILS .EQ. 1 ) GO TO 2125
      WRITE ( 6,2130 )
2130 FORMAT (     62X,23H ACCURACY DATA (METERS),
205  A         /   66X,16H HOR.      VERT. )
      GO TO 2135
2125 WRITE ( 6,2140 )
2140 FORMAT (     63X,21H ACCURACY DATA (MILS),
     A         /   66X,16H HOR.      VERT. )
210  2135 WRITE ( 6,1020 )
      WRITE ( 6,2150 ) XB    ,YB    ,SIGXB ,SIGYB ,SIGXL ,SIGYL ,SIGXR
     A                ,SIGYR ,PROBS ,SIGXS ,SIGYS
2150 FORMAT ( 10X,25H XB,YB          FIXED BIAS,28X,2F10.4  /
     A         10X,34H SIGXB,SIGYB  VAR. BIAS STD. DEV.,19X,2F10.4  /
215  B         10X,34H SIGXL,SIGYL  LAY ERROR STD. DEV.,19X,2F10.4  /
     C         10X,34H SIGXR,SIGYR  RD.-TO-RD.STD. DEV.,19X,2F10.4  /
     D         10X,36H PROBS        PROB. SENS. MISS. RD.,6X,F10.4  /
     E         10X,36H SIGXS,SIGYS  SENS. ERROR STD. DEV.,17X,2F10.4  )
      OPTW = PGH + PGS + PGCH + PGCS + SGHX + SGHY + SGSX + SGSY + CDRX
220  A     + CDRY + HSX + HSY
      IF (OPTW .EQ. 0.0 ) GO TO 2155
      WRITE ( 6,1010 )
      WRITE ( 6,2160 ) PGH   ,PGS   ,PGCH  ,PGCS  ,SGHX  ,SGHY  ,SGSX
     A                ,SGSY  ,CDRX  ,CDRY  ,HSX   ,HSY
225  2160 FORMAT ( 10X,38H PGH          GUNNER SENS. PROB. HIGH,5X,F10.4  /
     A         10X,37H PGS          GNR. SENS. PROB. SHORT,6X,F10.4  /
     B         10X,35H PGCH         G/C SENS. PROB. HIGH,8X,F10.4  /
     C         10X,36H PGCS         G/C SENS. PROB. SHORT,7X,F10.4  /
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     D          10X,35H SGHX,SGHY      GNR. SENS. S.D. HIGH,18X,2F10.4  /
230  E          10X,36H SGSX,SGSY      GNR. SENS. S.D. SHORT,17X,2F10.4  /
     F          10X,33H CDRX,CDRY      CMDR.-TO-GNR. S.D.,20X,2F10.4  /
     G          10X,33H HSX,HSY        HIT ADJ. STD. DEV.,20X,2F10.4  )
   2155 CONTINUE
        IF ( NHTKLL .EQ. 0 ) GOTO 2165
235     WRITE ( 6,1020 )
        WRITE ( 6,2140 )
        WRITE ( 6,1020 )
        WRITE ( 6,2170 ) XBH   ,YBH   ,SIGXBH,SIGYBH,XBL   ,YBL   ,SIGXBL
     A                  ,SIGYBL,XBS   ,YBS   ,SIGXBS,SIGYBS
240 2170 FORMAT ( 10X,23H XBH,YBH       BIAS HIT,30X,2F10.4  /
     A          10X,28H SIGXBH,SIGYBH STD. DEV. HIT,25X,2F10.4  /
     B          10X,29H XBL,YBL       BIAS LOST MISS,24X,2F10.4  /
     C          10X,34H SIGXBL,SIGYBL STD. DEV. LOST MISS,19X,2F10.4  /
     D          10X,31H XBS,YBS       BIAS SENSED MISS,22X,2F10.4  /
245  E          10X,36H SIGXBS,SIGYBS STD. DEV. SENSED MISS,17X,2F10.4  )
   2165 CONTINUE
        IF ( INTPL .EQ. 0 ) GO TO 2175
        INCRNG = 500
        IRNG2 = IRANGE/INCRNG + 1
250     DELRNG = IRNG2*INCRNG - IRANGE
        RATIO = DELRNG / 500.0
   2175 CONTINUE
        IF ( STD1 .EQ. 0.0 ) STD1 = 0.4983
        IF ( STD2 .EQ. 0.0 ) STD2 = 0.4983
255     GO TO 2300
   2200 READ  ( 5,1210 ) FLT   ,TF1   ,TFS   ,XM1   ,XM2   ,AMT1  ,AMT2
        WRITE ( 6,1212 ) FLT   ,TF1   ,TFS   ,XM1   ,XM2   ,AMT1  ,AMT2
        STD1 = 0.0
        STD2 = 0.0
260     WRITE ( 6,1212 ) STD1  ,STD2
        DO 2210 M = 1,3
        DO 2210 N = 1,6
        READ  ( 5,2220 ) XXB(M,N) ,YYB(M,N) ,SSIGXB(M,N)   ,SSIGYB(M,N)
   2220 FORMAT ( 20X,4F10.4 )
265     WRITE ( 6,2222 ) XXB(M,N) ,YYB(M,N) ,SSIGXB(M,N)   ,SSIGYB(M,N)
   2222 FORMAT ( 30X,4F10.4 )
   2210 CONTINUE
        SIGXL = 0.0
        WRITE ( 6,2230 ) SIGXL
270 2230 FORMAT ( 70X,F10.4 )
        READ  ( 5,2240 ) SIGYL ,SIGXR ,SIGYR ,PROBS ,SIGXS ,SIGYS
   2240 FORMAT ( 6F10.4 / / / / )
        WRITE ( 6,1212 ) SIGYL ,SIGXR ,SIGYR ,PROBS ,SIGXS ,SIGYS
   2300 CONVRT = 1.0
275     PI = 3.14159
        R = IRANGE
        IF ( IMILS .EQ. 0 ) GO TO 2305
        CONVRT = R*PI / 3200.0
   2305 CONVRT = CONVRT * 39.37
280     IF ( ISTMOV .EQ. 1 ) GO TO 3000
        XB = XB * CONVRT
        YB = YB * CONVRT
        SIGXB = SIGXB * CONVRT
        SIGYB = SIGYB * CONVRT
285     SIGXL = SIGXL * CONVRT
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247- 251 IF NEEDED, RANGE INTERPOLATION FACTOR RATIO IS DETERMINED. FOR EXAMPLE, RANGES OF 600 AND 2350 METERS WOULD CORRESPOND TO 0.8 AND 0.3 RESPECTIVELY. PRODUCT OF RATIO AND 500 IS DIFFERENCE IN METERS BETWEEN RANGE IRANGE AND NEXT HIGHER MULTIPLE OF 500 METERS.

253- 254 FOR CONVENIENCE, ZEROS CAN BE USED FOR STD1 AND STD2 ON INPUT CARD R3 INSTEAD OF 0.4983 WHICH IS GENERALLY APPLICABLE. IF THIS HAS BEEN DONE, RESET STD1 AND STD2.

255 SKIP PROGRAM LINES 256 THROUGH 273.

256- 273 READ AND WRITE INPUT CARDS CONTAINING FIRST ROUND BIAS AND STANDARD DEVIATION DATA NEEDED FOR MOVING TARGET OR MOVING FIRING WEAPON RUN. SINCE TIMES ARE NOT INVOLVED, FIRST CARD CAN CONTAIN ONLY ZEROS AND STD1 AND STD2 ARE SET TO 0. DO 2210 LOOP PROCESSES SET OF 18 INPUT CARDS AND STORES DATA IN XXB, YYB, SSIGXB, AND SSIGYB ARRAYS. SINCE STANDARD DEVIATIONS ENTERED IN LATTER TWO ARRAYS ALREADY ACCOUNT FOR RANDOM ERRORS AS WELL AS OTHER ERROR CONTRIBUTORS, SIGXL IS SET TO 0. LAST CARD CAN CONTAIN ONLY ZEROS BECAUSE QUANTITIES RELATED TO SUBSEQUENT ROUND SENSING AND ADJUSTMENT AS WELL AS TO RANDOM ERRORS ARE UNNEEDED. THE 18 SETS OF INPUT BIASES AND STANDARD DEVIATIONS MAY INCLUDE DUMMY SETS FOR WHICH CALCULATIONS ARE NOT TO BE MADE. SUCH DUMMY SETS ARE IDENTIFIED BY HORIZONTAL BIAS SETTING OF 999.9999.

274- 279 CONVERSION FACTOR CONVRT IS SET TO APPROPRIATE VALUE FOR CHANGING METERS OR MILS TO INCHES.

280 SKIP PROGRAM LINES 281 THROUGH 328 FOR MOVING TARGET OR MOVING FIRING WEAPON RUN.

281- 298 CONVERT FROM METERS OR MILS TO INCHES.

299 SKIP PROGRAM LINES 300 THROUGH 328 IF ASSOCIATED QUANTITIES ARE UNNEEDED.

300- 312 CONVERT FROM MILS TO INCHES. IF IMILS EQUALS 0, PREVIOUS SETTING OF CONVRT HAS NOT PROVIDED FOR CONVERSION FROM MILS TO METERS.

313- 328 ENTER BIASES AND STANDARD DEVIATIONS IN BBX, BBY, SSIGX, AND SSIGY ARRAYS.

330 SKIP PROGRAM LINES 331 THROUGH 462 IF TARGET SHAPE DATA FROM CARDS ARE NEEDED.

331- 462 CYCLE FOR READING AND PROCESSING TARGET VULNERABILITY DATA FROM TAPE OR DISC.

331- 334 DO NOT READ AND PROCESS VULNERABILITY DATA FROM TAPE OR DISC WHEN NEEDED INFORMATION HAS ALREADY BEEN READ AND PROCESSED. CONDITION INVOLVING NRANGE, INTPL, AND ISPLIT COVERS INSTANCES WHERE FIRST RANGE OF CONCERN FOR RANGE INTERPOLATION OF VULNERABILITY DATA HAS BEEN INVOLVED IN PREVIOUS RANGE CYCLE. JNTPL EQUALLING 1 INDICATES THAT SECOND RANGE USED IN INTERPOLATION OF IMMEDIATELY PRECEDING RANGE CYCLE IS RANGE OF CONCERN FOR CURRENT CYCLE. VULNERABILITY DATA THAT DO NOT VARY WITH RANGE ARE READ AND PROCESSED IN FIRST RANGE CYCLE ONLY AND CAN THEN BE REUSED.

335 CONDITION IS ASSOCIATED WITH RANGE INTERPOLATION OF TARGET VULNERABILITY DATA. ISPLIT EQUALLING 2 INDICATES THAT CALCULATIONS HAVE ALREADY BEEN COMPLETED FOR LESSER OF TWO RANGES BRACKETING ACTUAL RANGE AND PARTICULAR PAIR OF FORWARD AND REVERSE ORIENTATION ANGLES. IF FORWARD ANGLE OF 0 DEGREES IS INVOLVED, CONTINUE WITH PROGRAM LINES 336 THROUGH 374 BEFORE OBTAINING VULNERABILITY DATA FOR RANGE BRACKETING THAT OF TARGET ON HIGH SIDE AND FOR ANGLES OF 0 AND 180 DEGREES. IF FORWARD ANGLE IS 30, 60, OR 90 DEGREES, SKIP TO PROGRAM STATEMENT 3200.

```
                SIGYL = SIGYL * CONVRT
                SIGXR = SIGXR * CONVRT
                SIGYR = SIGYR * CONVRT
                SIGXS = SIGXS * CONVRT
290             SIGYS = SIGYS * CONVRT
                SGHX = SGHX * CONVRT
                SGHY = SGHY * CONVRT
                SGSX = SGSX * CONVRT
                SGSY = SGSY * CONVRT
295             CDRX = CDRX * CONVRT
                CDRY = CDRY * CONVRT
                HSX = HSX * CONVRT
                HSY = HSY * CONVRT
                IF ( NHTKLL .EQ. 0 ) GOTO 3000
300             IF ( IMILS .EQ. 0 ) CONVRT = CONVRT * R*PI/3200.0
                XBH = XBH * CONVRT
                YBH = YBH * CONVRT
                SIGXBH = SIGXBH * CONVRT
                SIGYBH = SIGYBH * CONVRT
305             XBL = XBL * CONVRT
                YBL = YBL * CONVRT
                SIGXBL = SIGXBL * CONVRT
                SIGYBL = SIGYBL * CONVRT
                XBS = XBS * CONVRT
310             YBS = YBS * CONVRT
                SIGXBS = SIGXBS * CONVRT
                SIGYBS = SIGYBS * CONVRT
                BBX(1) = XB
                BBY(1) = YB
315             BBX(2) = XBH
                BBY(2) = YBH
                BBX(3) = XBL
                BBY(3) = YBL
                BBX(4) = XBS
320             BBY(4) = YBS
                SSIGX(1) = SQRT(SIGXB**2+SIGXL**2+SIGXR**2)
                SSIGY(1) = SQRT(SIGYB**2+SIGYL**2+SIGYR**2)
                SSIGX(2) = SIGXBH
                SSIGY(2) = SIGYBH
325             SSIGX(3) = SIGXBL
                SSIGY(3) = SIGYBL
                SSIGX(4) = SIGXBS
                SSIGY(4) = SIGYBS
           3000 CONTINUE
330             IF ( NSTCRD .GT. 0 ) GO TO 3800
                IF ( NRANGE .GT. 1 .AND. INTPL .EQ. 1 .AND. ISPLIT .EQ. 0 ) GO TO
               A    4010
                IF ( JNTPL .EQ. 1 ) GO TO 4010
                IF ( NRDTYP .EQ. 0 .AND. NRANGE .GT. 1 ) GO TO 4000
335             IF ( ISPLIT .EQ. 2 .AND. NANGLE .NE. 1 ) GO TO 3200
                WRITE ( 6,1010 )
                IF ( NEJECT .EQ. 1 ) READ ( IU,3110 ) A
           3110 FORMAT ( 80A1 )
                IF ( EOF(IU) .EQ. 1.0 ) GO TO 301
340         301 CONTINUE
                IF ( ISTMOV .EQ. 1 .AND. NRANGE .NE. 1 ) READ ( IU,3110 ) A
                IF ( EOF(IU) .EQ. 1.0 ) GO TO 312
```

```
      312 CONTINUE
          READ ( IU,3110 ) ITAPE
          IF ( EOF(IU) .EQ. 1.0 ) GO TO 302
      302 CONTINUE
          WRITE ( 6,3112 ) ITAPE
     3112 FORMAT ( 10X,80A1 )
          DO 3120 K = 1,74
          IF ( ITAPE(K) .NE. IDCODE(4) ) GO TO 3120
          IF ( ITAPE(K+1) .NE. IDCODE(5) ) GO TO 3120
          IF ( ITAPE(K+2) .NE. IDCODE(6) ) GO TO 3120
          M = K+3
          GO TO 3130
     3120 CONTINUE
          GO TO 3140
     3130 DO 3150 L = M,77
          IF ( ITAPE(L) .NE. IDCODE(7) ) GO TO 3150
          IF ( ITAPE(L+1) .NE. IDCODE(8) ) GO TO 3150
          IF ( ITAPE(L+2) .NE. IDCODE(9) ) GO TO 3150
          IF ( ITAPE(L+3) .NE. IDCODE(10) ) GO TO 3150
          GO TO 3160
     3150 CONTINUE
     3140 WRITE ( 6,3170 )
     3170 FORMAT ( 1HO, 10X,32H PROJECTILE/TARGET CODE MISMATCH )
          GO TO 9900
     3160 CONTINUE
          WRITE ( 6,3180 ) ( IDCODE(I),I=1,3 ),( IDCODE(I),I=4,6 )
         A                 ,( IDCODE(I),I=7,10 ),IRANGE
     3180 FORMAT ( 24X,26H TASK SHEET IDENTIFICATION,10X,3A1  /
         A          24X,16H PROJECTILE CODE,20X,3A1  /
         B          24X,12H TARGET CODE,23X,4A1  /
         C          24X,16H RANGE IN METERS,18X,I5  )
          IANGLE = 1
     3200 IF ( ISPLIT .NE. 2 ) IC = IANGLE
          IB = IC * 2
          IA = IB - 1
          WRITE ( 6,1010 )
          READ ( IU,3110 ) A
          IF ( EOF(IU) .EQ. 1.0 ) GO TO 303
      303 CONTINUE
          NSKIP = 3
          WRITE ( 6,1020 )
          DO 3210 L = 1,NSKIP
          READ ( IU,3110 ) A
          IF ( EOF(IU) .EQ. 1.0 ) GO TO 304
      304 CONTINUE
          WRITE ( 6,3112 ) A
     3210 CONTINUE
          YTEMPL(IC) = 9999.0
          YTEMPH = -9999.0
          XTEMPL(IC) = 9999.0
          XTEMPH(IC) = -9999.0
          M = 1
     3400 IF ( NTGT .GT. 1 ) GO TO 3405
          READ ( IU,3410 ) X,Y,( PKRLFT(J),J=1,4 ),( PKRLFT(J),J=6,9 )
     3410 FORMAT ( 1X,F6.1,F7.1,5X,4F7.3,6X,4F7.3 )
          GO TO 305
     3405 IF ( NTGT .GT. 2) GO TO 3415
```

337- 343 SPECIAL STATEMENTS NEEDED TO READ AND IGNORE BLANK LINE OR EJECT PAGE LINE PERIODICALLY USED ON TAPE OR DISC.

344- 373 READ NEXT LINE OF INFORMATION FROM TAPE OR DISC. THIS LINE SHOULD CONTAIN PROJECTILE CODE, RANGE, AND TARGET CODE. VERIFY AGREEMENT OF PROJECTILE AND TARGET CODES WITH THOSE IN IDCODE. IF DISCREPANCY IS FOUND, PRINT ERROR INDICATION AND GO TO PROGRAM STATEMENT 9900 TO STOP RUN. OTHERWISE WRITE SPECIFIED REFERENCE INFORMATION.

374 INITIAL SETTING.

375- 460 CYCLE FOR IANGLE EQUALLING 1, 2, 3, OR 4. THESE VALUES CORRESPOND TO TARGET ORIENTATION ANGLES OF 0, 30, 60, AND 90 DEGREES RESPECTIVELY TOGETHER WITH ASSOCIATED REVERSE ANGLES.

375- 377 INITIAL SETTINGS.

379- 389 READ BLANK LINE FROM TAPE OR DISC. ALSO READ AND WRITE THREE LINES OF HEADER INFORMATION SUCH AS 0 DEG ELEV, 30 DEG AZIM ETC...

390- 394 INITIAL SETTINGS.

395- 447 CYCLE FOR EACH TARGET CELL.

395- 405 READ CELL CENTER COORDINATES AND RELATED VULNERABILITY DATA. FORMAT PREVIOUSLY USED TO STORE NUMBERS ON TAPE OR DISC IS IDENTIFIED BY NTGT. LABEL CELL COORDINATES AS X AND Y. WCELL INDICATES WHETHER X AND Y ARE IN INCHES OR MILLIMETERS. STORE VULNERABILITY DATA IN PKRLFT ARRAY, USING PKRLFT(1) AND PKRLFT(6) FOR M (MOBILITY) KILL PROBABILITIES, PKRLFT(2) AND (7) FOR F (FIREPOWER) KILL PROBABILITIES, (3) AND (8) FOR M OR F (MOBILITY AND/OR FIREPOWER) KILL PROBABILITIES, (4) AND (9) FOR K (COMPLETE DESTRUCTION) KILL PROBABILITIES AND IF NECESSARY (5) AND (10) FOR PASSENGER PERSONNEL CASUALTIES. PKRLFT(1) THROUGH (5) ARE ASSOCIATED WITH TARGET ORIENTATION ANGLES OF 0, 30, 60, AND 90 DEGREES, AND PKRLFT(6) THROUGH (10) WITH CORRESPONDING REVERSE ANGLES.

406- 411 NUMBER READ AS X COORDINATE OF CELL CENTER MAY EXCEPTIONALLY BE 999.9 USED ON TAPE OR DISC TO INDICATE ALL DATA FOR PARTICULAR SET OF FORWARD AND REVERSE ANGLES HAVE BEEN READ. IN THAT CASE, MULTIPLICATION OF X BY 10.0 SETS IEND TO 9999. ADDITION OF 10000.001 TO X AND Y ELIMINATES ALL MINUS SIGNS. INTEGER QUANTITIES IMODX AND IMODY ARE READILY COMBINED INTO SINGLE ENTRY STORABLE IN IMODXY ARRAY. WHEN X EQUALS 999.9, IMODX IS SET TO 19990 AND COMBINED WITH Y COORDINATE 0 BEFORE STORAGE OF RESULT IN IMODXY ARRAY. AFTER END INDICATOR IS THUS STORED, RUN CONTINUES AT PROGRAM STATEMENT 3700.

412- 427 IGNORE THESE SPECIAL STATEMENTS FOR NADJST EQUALLING 2 THROUGH 5.

428- 430 IF CELL COORDINATES ARE IN MILLIMETERS, CONVERT TO INCHES.

431- 434 UPDATE, AS NECESSARY, MINIMUM AND MAXIMUM COORDINATES RELATED TO RECTANGLE ENCLOSING TARGET. IF PREVIOUSLY ESTABLISHED VALUE OF YTEMPL(IC) IS GREATER THAN Y, RESET YTEMPL(IC) TO Y. SIMILARLY, RESET YTEMPH IF LESS THAN Y, XTEMPL(IC) IF GREATER THAN X, AND XTEMPH(IC) IF LESS THAN X.

435 IF NPRHIT EQUALS 1, SKIP PROGRAM LINES 436 THROUGH 447 SINCE THEY INVOLVE UNNEEDED TARGET VULNERABILITY DATA.

436- 447 QUANTITIES IN PKRLFT ARRAY CONTAIN THREE DECIMAL PLACES. CONVERT TO CONVENIENT INTEGER FORM AND ENTER IN IP ARRAY. PACK FIRST FIVE IP VALUES INTO SINGLE NUMBER AND STORE RESULT IN MPK ARRAY. TARGET CELL INVOLVED IS IDENTIFIED BY M. IA EQUALS 1, 3, 5, OR 7 FOR TARGET ORIENTATION ANGLE OF 0, 30, 60, OR

```
400                READ ( IU,3420 ) X,Y,PKRLFT
                3420 FORMAT ( 1X,2F6.0,2(3X,4F6.2,F7.2) )
                     GO TO 305
                3415 READ ( IU,3430 ) X,Y,PKRLFT
                3430 FORMAT ( 1X,F6.1,F7.1,5X,2(4F7.3,F6.1) )
405              305 IF ( EOF(IU) .EQ. 1.0 ) GO TO 3500
                3500 IEND = X * 10.0
                     IMODX = X + 10000.001
                     IF ( IEND .EQ. 9999 ) IMODX = 19999
                     IMODY = Y + 10000.001
410                  IMODXY(M,IC) = IMODX*100000 + IMODY
                     IF ( IEND .EQ. 9999 ) GO TO 3700
                     IF ( NADJST .EQ. 2 .AND. IANGLE .EQ. 2 ) GO TO 3600
                     IF ( NADJST .EQ. 3 .AND. IANGLE .EQ. 2 ) GO TO 3600
                     IF ( NADJST .EQ. 4 .AND. IANGLE .EQ. 2 ) GO TO 3600
415                  IF ( NADJST .EQ. 5 .AND. IANGLE .EQ. 2 ) GO TO 3600
                     IF ( NADJST .EQ. 2 .AND. IANGLE .EQ. 3 ) GO TO 3600
                     IF ( NADJST .EQ. 3 .AND. IANGLE .EQ. 3 ) GO TO 3600
                     IF ( NADJST .EQ. 4 .AND. IANGLE .EQ. 3 ) GO TO 3600
                     IF ( NADJST .EQ. 5 .AND. IANGLE .EQ. 3 ) GO TO 3600
420                  IF ( NADJST .EQ. 2 .AND. IANGLE .EQ. 4 .AND. YBASE .GT. 0.0 ) GO T
                    A    O 3600
                     IF ( NADJST .EQ. 3 .AND. IANGLE .EQ. 4 .AND. YBASE .GT. 0.0 ) GO T
                    A    O 3600
                     IF ( NADJST .EQ. 4 .AND. IANGLE .EQ. 4 .AND. YBASE .GT. 0.0 ) GO T
425                 A    O 3600
                     IF ( NADJST .EQ. 5 .AND. IANGLE .EQ. 4 .AND. YBASE .GT. 0.0 ) GO T
                    A    O 3600
                     IF ( WCELL .EQ. 4.0 ) GO TO 3505
                     X = X / 25.4
430                  Y = Y / 25.4
                3505 YTEMPL(IC) = AMIN1(YTEMPL(IC),Y)
                     YTEMPH = AMAX1(YTEMPH,Y)
                     XTEMPL(IC) = AMIN1(XTEMPL(IC),X)
                     XTEMPH(IC) = AMAX1(XTEMPH(IC),X)
435                  IF ( NPRHIT .EQ. 1 ) GO TO 3600
                     DO 3510 K = 1,10
                3510 IP(K) = 1000.0*PKRLFT(K) + 0.1
                     MPK(M,IA) = SHIFT(IP(1),49) .OR.
                    A            SHIFT(IP(2),38) .OR.
440                 B            SHIFT(IP(3),27) .OR.
                    C            SHIFT(IP(4),16) .OR.
                    D            IP(5)
                     MPK(M,IB) = SHIFT(IP(6),49) .OR.
                    A            SHIFT(IP(7),38) .OR.
445                 B            SHIFT(IP(8),27) .OR.
                    C            SHIFT(IP(9),16) .OR.
                    D            IP(10)
                3600 CONTINUE
                     M = M + 1
450                  IF ( M .GT. 3000 ) GO TO 3605
                     GO TO 3400
                3605 WRITE ( 6,3610 )
                3610 FORMAT ( 1H0, 10X,22H TARGET MATRIX TOO BIG )
                     GO TO 9900
455             3700 CONTINUE
                     NXTEMP(IC) = (XTEMPH(IC)-XTEMPL(IC))/W + 1.001
```

90 DEGREES RESPECTIVELY. SIMILARLY PACK LAST FIVE IP VALUES FOR STORAGE IN MPK ARRAY. IB IS ASSOCIATED WITH REVERSE ANGLES AND EQUALS 1 MORE THAN CORRESPONDING IA VALUE.

448– 454 RESET CELL COUNTER M. IF M THEN EQUALS 3001, 3000 CELLS HAVE ALREADY BEEN PROCESSED AND MAXIMUM ALLOWED 2999 CELLS HAS BEEN EXCEEDED. IF TARGET CONTAINS EXACTLY 2999 CELLS, CELL 3000 IS ASSOCIATED WITH 999.9 ENTRY. IF LIMIT HAS BEEN VIOLATED, PRINT ERROR INDICATION AND GO TO PROGRAM STATEMENT 9900 TO STOP RUN. OTHERWISE RECYCLE FOR NEXT CELL.

456– 457 CALCULATE NUMBER OF CELLS ALONG EACH SIDE OF RECTANGLE THAT IS JUST LARGE ENOUGH TO ENCLOSE TARGET FOR FORWARD AND REVERSE ORIENTATIONS CORRESPONDING TO IC. RECTANGLE HAS NXTEMP(IC) CELLS IN HORIZONTAL DIRECTION AND NYTEMP(IC) CELLS IN VERTICAL DIRECTION. NUMBERS OF CELLS BASED ON DIFFERENCES BETWEEN MINIMUM AND MAXIMUM COORDINATES OF CELL CENTERS ARE INCREASED BY 1.000 TO ACCOUNT FOR HALF CELLS AT EACH EDGE. ADDITION OF .001 COVERS ROUNDING INACCURACIES.

458 WHEN RANGE INTERPOLATION OF VULNERABILITY DATA IS INVOLVED AND TARGET RANGE IS NOT FIRST ONE CONSIDERED IN RUN, CONTINUE AT PROGRAM STATEMENT 4100 FOR EACH IANGLE VALUE.

459 CONTINUE AT PROGRAM STATEMENT 4000 IF IANGLE VALUES 1 THROUGH 4 HAVE ALL BEEN COVERED.

460 IF THIRD OF FOUR INTERPOLATION STEPS CORRESPONDING TO ISPLIT IS OF CURRENT CONCERN, CONTINUE AT PROGRAM STATEMENT 4020 FOR PARTICULAR IANGLE VALUE UNDER CONSIDERATION.

461– 462 SINCE IANGLE VALUES 1 THROUGH 4 HAVE NOT ALL BEEN PROCESSED, REPEAT FOR NEXT VALUE.

463– 505 CYCLE FOR PROCESSING TARGET SHAPE DATA READ FROM CARDS.

464 INITIAL SETTING.

465– 471 INITIAL SETTINGS. JCELL IS INTEGER FORM OF WCELL.

472– 473 IT VALUES 1, 2, 3, AND 4 CORRESPOND TO TARGET ORIENTATION ANGLES OF 0, 30, 60, AND 90 DEGREES RESPECTIVELY. COUNTER K INDICATES WHICH STRIP OF TARGET CELLS IS OF CURRENT CONCERN. STRIP CAN EXCEPTIONALLY CONSIST OF ONLY ONE CELL. SET JY TO EQUAL Y COORDINATE COMMON TO CENTERS OF ALL CELLS IN STRIP. SET JX TO EQUAL X COORDINATE OF CENTER OF CELL AT LEFT EDGE OF STRIP.

474– 477 ADDITION OF 10000 TO JX AND JY ELIMINATES ALL MINUS SIGNS. COMBINE IMODX AND IMODY AND STORE RESULTING QUANTITY IN IMODXY ARRAY. WHEN JX EQUALLING 9999 INDICATES THAT ALL TARGET CELLS FOR ANGLE CORRESPONDING TO IT HAVE BEEN PROCESSED, RUN CONTINUES AT PROGRAM STATEMENT 3900.

478– 482 IF CELL COORDINATES ARE IN MILLIMETERS, CONVERT TO INCHES.

483– 486 UPDATE, AS NECESSARY, MINIMUM AND MAXIMUM COORDINATES RELATED TO RECTANGLE ENCLOSING TARGET. IF PREVIOUSLY ESTABLISHED VALUE OF YTEMPL(IT) IS GREATER THAN Y, RESET YTEMPL(IT) TO Y. SIMILARLY, RESET YTEMPH IF LESS THAN Y, XTEMPL(IT) IF GREATER THAN X, AND XTEMPH(IT) IF LESS THAN X.

487 RESET CELL COUNTER.

488 CELL COUNTER SHOULD NEVER EXCEED 3000. IF LIMIT HAS BEEN VIOLATED, GO TO PROGRAM STATEMENT 3845.

```
                      NYTEMP(IC) = (YTEMPH-YTEMPL(IC))/W + 1.001
                      IF ( INTPL .EQ. 1 .AND. NRANGE .GT. 1 ) GO TO 4100
                      IF ( IANGLE .EQ. 4 ) GO TO 4000
                      IF ( ISPLIT .EQ. 2 ) GO TO 4020
                      IANGLE = IANGLE + 1
                      GO TO 3200
                 3800 CONTINUE
                      IT = 1
                 3805 YTEMPL(IT) = 9999.0
                      YTEMPH = -9999.0
                      XTEMPL(IT) = 9999.0
                      XTEMPH(IT) = -9999.0
                      M = 1
                      K = 1
                      JCELL = WCELL
                 3810 JY = NCTRY(K,IT)
                      JX = NCTRXL(K,IT)
                 3820 IMODX = JX + 10000
                      IMODY = JY + 10000
                      IMODXY(M,IT) = IMODX*100000 + IMODY
                      IF ( JX .EQ. 9999 ) GO TO 3900
                      X = JX
                      Y = JY
                      IF ( WCELL .EQ. 4.0 ) GO TO 3825
                      X = X / 25.4
                      Y = Y / 25.4
                 3825 YTEMPL(IT) = AMIN1(YTEMPL(IT),Y)
                      YTEMPH = AMAX1(YTEMPH,Y)
                      XTEMPL(IT) = AMIN1(XTEMPL(IT),X)
                      XTEMPH(IT) = AMAX1(XTEMPH(IT),X)
                      M = M + 1
                      IF ( M .GT. 3000 ) GO TO 3845
                      IF ( JX .EQ. NCTRXR(K,IT) ) GO TO 3835
                      JX = JX + JCELL
                      GO TO 3820
                 3835 K = K + 1
                      GO TO 3810
                 3845 WRITE ( 6,3610 )
                      GO TO 9900
                 3900 CONTINUE
                      MCELLS = M - 1
                      WRITE ( 6,1020 )
                      WRITE ( 6,1122 ) MCELLS
                      NXTEMP(IT) = (XTEMPH(IT)-XTEMPL(IT))/W + 1.001
                      NYTEMP(IT) = (YTEMPH-YTEMPL(IT))/W + 1.001
                      IF ( IT .EQ. 4 ) GO TO 4000
                      IT = IT + 1
                      IF ( KTRGTC(IT) .EQ. 0 ) GO TO 4000
                      GO TO 3805
                 4000 CONTINUE
                      IF ( NSTCRD .GT. 0 ) GO TO 4200
                 4010 NANGLE = 1
                 4020 NALPHA = NANGLE / 2
                      NBETA = NALPHA * 2
                      IF ( NBETA .EQ. NANGLE ) GO TO 4105
                      IC = NALPHA + 1
                      IF ( ISTMOV .NE. 1 ) GO TO 4025
```

489- 493 NCTRXR(K,IT) IS X COORDINATE OF CENTER OF CELL AT RIGHT EDGE OF STRIP. WHEN JX EQUALS THIS COORDINATE, STRIP HAS BEEN COMPLETELY PROCESSED. IN THAT CASE, RESET K TO CORRESPOND TO NEXT STRIP OF TARGET CELLS AND CONTINUE AT PROGRAM STATEMENT 3810. IN OTHER INSTANCES, RESET JX TO EQUAL X COORDINATE OF NEXT CELL IN STRIP AND BEGIN PROCESSING FOR THIS CELL AT PROGRAM STATEMENT 3820.

494- 495 PRINT ERROR INDICATION AND GO TO PROGRAM STATEMENT 9900 TO STOP RUN.

497- 499 MCELLS IS TOTAL NUMBER OF TARGET CELLS FOR ANGLE ASSOCIATED WITH IT. CELL COUNTER M IS REDUCED BY 1 BECAUSE END INDICATOR HAS BEEN INCLUDED. WRITE MCELLS FOR POSSIBLE USE IN CHECKING RUN OUTPUT.

500- 501 CALCULATE NUMBER OF CELLS ALONG EACH SIDE OF RECTANGLE THAT IS JUST LARGE ENOUGH TO ENCLOSE TARGET FOR ORIENTATION CORRESPONDING TO IT. EXPLANATIONS FOR PROGRAM LINES 456 AND 457 APPLY HERE ALSO IF IC IS REPLACED BY IT.

502 CONTINUE AT PROGRAM STATEMENT 4000 IF IT VALUES 1 THROUGH 4 HAVE ALL BEEN COVERED.

503- 505 RESET IT FOR NEXT ORIENTATION ANGLE. KTRGTC(IT) CAN EQUAL 0 ONLY IF RUN INVOLVES FEWER THAN FOUR ANGLES. IN THAT CASE, CONTINUE AT PROGRAM STATEMENT 4000. OTHERWISE BEGIN PROCESSING FOR NEW ORIENTATION AT PROGRAM STATEMENT 3805.

507 SKIP PROGRAM LINES 508 THROUGH 532 IF RUN DOES NOT INVOLVE VULNERABILITY DATA FROM TAPE OR DISC.

508 INITIAL SETTING.

509- 510 NANGLE EQUALS 1, 3, 5, OR 7 FOR TARGET ORIENTATION ANGLE OF 0, 30, 60, OR 90 DEGREES RESPECTIVELY AND 2, 4, 6, OR 8 FOR CORRESPONDING REVERSE ANGLE. NALPHA EQUALS 0 WHEN NANGLE IS 1 OR 1 WHEN NANGLE IS 2. CORRESPONDING VALUES OF NBETA ARE 0 OR 2 RESPECTIVELY FOR NANGLE EQUALLING 1 OR 2. NBETA ALWAYS DIFFERS FROM NANGLE FOR FORWARD ORIENTATION ANGLES AND EQUALS NANGLE FOR REVERSE ANGLES.

511 SKIP PROGRAM LINES 512 THROUGH 542 WHEN NANGLE CORRESPONDS TO REVERSE ANGLE.

512 IC IS SET TO 1, 2, 3, OR 4 RESPECTIVELY FOR NANGLE EQUALLING 1, 3, 5, OR 7.

513 PROGRAM LINES 514 THROUGH 523 APPLY ONLY FOR MOVING TARGET OR MOVING FIRING WEAPON RUN AND ARE SKIPPED OTHERWISE.

514 IF DUMMY SET FOR WHICH NO CALCULATIONS ARE NEEDED IS INVOLVED, SKIP PROGRAM LINES 515 THROUGH 1374.

515- 523 INITIAL SETTINGS.

524- 528 IGNORE STATEMENTS APPLICABLE ONLY FOR NADJST EQUALLING 2 THROUGH 5.

530- 531 INITIAL SETTINGS.

532 SKIP PROGRAM LINES 533 THROUGH 537 APPLICABLE ONLY WHEN RUN INVOLVES TARGET SHAPE DATA FROM CARDS.

533- 537 SPECIAL SETTINGS ARE NEEDED WHEN TARGET SHAPE DATA FROM CARDS ARE USED.

534 INITIAL SETTING.

535- 537 SET IC, NANGLE, AND NBETA SO THAT PROGRAM STATEMENT 4100 AND SUBSEQUENT

```
      4035 IF ( XXB(IC,MSET) .EQ. 999.9999 ) GO TO 9305
  515      BBX(1) = XXB(IC,MSET) * CONVRT
           BBY(1) = YYB(IC,MSET) * CONVRT
           SSIGX(1) = SSIGXB(IC,MSET) * CONVRT
           SSIGY(1) = SSIGYB(IC,MSET) * CONVRT
           DO 4040 N = 2,4
  520      BBX(N) = 0.0
           BBY(N) = 0.0
           SSIGX(N) = 0.0
      4040 SSIGY(N) = 0.0
      4025 IF ( NADJST .LT. 2 .OR. NADJST .GT. 5 ) GO TO 4045
  525      IF ( IC .EQ. 2 .OR. IC .EQ. 3 ) NANGLE = NANGLE + 1
           IF ( IC .EQ. 2 .OR. IC .EQ. 3 ) GO TO 9100
           IF ( IC .EQ. 4 .AND. YBASE .GT. 0.0 ) NANGLE = NANGLE + 1
           IF ( IC .EQ. 4 .AND. YBASE .GT. 0.0 ) GO TO 9100
      4045 CONTINUE
  530      IB = IC * 2
           IA = IB - 1
           GO TO 4100
      4200 CONTINUE
           NTRGTC = 1
  535 4210 IC = NTRGTC
           NANGLE = 0
           NBETA = 9
      4100 NX = NXTEMP(IC)
           NY = NYTEMP(IC)
  540      CNX = NX
           CNY = NY
           XCORNR = XTEMPL(IC)
      4105 IF ( NBETA .EQ. NANGLE ) XCORNR = -XTEMPH(IC)
           DO 4110 I = 1,NX
  545      U = I - 1
      4110 AX(I) = XCORNR + U*W
           DO 4120 J = 1,NY
           V = J - 1
      4120 AY(J) = YTEMPL(IC) + V*W
  550      DO 4130 I = 1,NX
           DO 4130 J = 1,NY
      4130 IK(J,I) = 0
           DO 4140 M = 1,3000
           IMODX = IMODXY(M,IC)/100000
  555      IMODY = IMODXY(M,IC) - IMODX*100000
           X = IMODX - 10000
           IEND = X
           IF ( IEND .EQ. 9999 ) GO TO 4145
           IF ( NBETA .EQ. NANGLE ) X = -X
  560      Y = IMODY - 10000
           IF ( WCELL .EQ. 4.0 ) GO TO 4155
           X = X / 25.4
           Y = Y / 25.4
      4155 I = (X-XCORNR)/W + 1.001
  565      J = (Y-YTEMPL(IC))/W + 1.001
      4140 IK(J,I) = M
      4145 CONTINUE
           IF ( NHTKLL .EQ. 9 ) GOTO 7400
           IF ( NSTCRD .GT. 0 ) GO TO 4300
  570      IF ( INTPL. EQ. 0 .OR. ISPLIT .EQ. 0 ) GO TO 4300
```

INSTRUCTIONS APPLY FOR TARGET SHAPE CARD INPUT AS WELL AS FOR VULNERABILITY DATA INPUT FROM TAPE OR DISC. SELECTION OF ARBITRARY BUT DIFFERENT VALUES FOR NANGLE AND NBETA ENSURES CALCULATIONS NORMALLY ASSOCIATED WITH REVERSE ANGLES ARE NOT ATTEMPTED.

538- 541 NX AND NY ARE SET TO EQUAL NUMBERS OF CELLS ON EDGES OF SMALLEST RECTANGLE ENCLOSING TARGET FOR IC VALUE OF CURRENT CONCERN. CNX AND CNY ARE REAL FORMS.

542 XCORNR IS SMALLEST X COORDINATE CORRESPONDING TO CENTER OF AT LEAST ONE TARGET CELL. FOR EXAMPLE, IF PREVIOUS CALCULATIONS HAVE RESULTED IN XTEMPL(IC) BEING -204 AND XTEMPH(IC) 128 FOR IC VALUE OF INTEREST, XCORNR EQUALS -204.

543 XCORNR NEEDS TO BE RESET FOR REVERSE ANGLE. FOR EXAMPLE, IF XTEMPL(IC) EQUALS -204 AND XTEMPH(IC) 128, CORRECT SETTING FOR XCORNR IS NOW -128.

544- 549 AX AND AY ARRAYS NEED TO CONTAIN X AND Y COORDINATES RESPECTIVELY OF CENTERS OF CELLS IN SMALLEST RECTANGLE ENCLOSING TARGET. ARRAYS MAY POSSIBLY INCLUDE SOME VALUES FOR WHICH THERE IS NO CORRESPONDING TARGET CELL.

550- 552 INITIAL SETTINGS.

553- 566 COORDINATES OF CENTER OF EACH TARGET CELL ARE RETRIEVED AND CONVERTED TO PAIR OF INDICES J AND I THAT IDENTIFY CELL LOCATION IN RECTANGLE ENCLOSING TARGET. ONCE PROCESSING IS DONE FOR ALL CELLS, IK ARRAY CONTAINS 1) ZEROS FOR VALUES OF J AND I ASSOCIATED WITH CELLS OUTSIDE TARGET, AND 2) CELL COUNTER INDEX M FOR J AND I PAIRS CORRESPONDING TO TARGET CELLS. USE OF INDICES J AND I IN IK ARRAY PARALLELS EARLIER USE OF THESE SAME INDICES IN AY AND AX ARRAYS RESPECTIVELY.

568 SKIP PROGRAM LINES 569 THROUGH 1132 IF NHTKLL INDICATES RUN DOES NOT INVOLVE SIMULATED FIRING ENGAGEMENTS.

569- 570 SKIP PROGRAM LINES 571 THROUGH 574 UNLESS ISPLIT EQUALLING 1, 2, OR 3 INDICATES FIRST, SECOND, OR THIRD OF FOUR SETS OF SIMULATED ENGAGEMENTS INVOLVED IN RANGE INTERPOLATION HAVE BEEN COMPLETED.

571- 574 ISPLIT EQUALLING 1 INDICATES FIRST SET OF SIMULATED ENGAGEMENTS INVOLVED IN RANGE INTERPOLATION HAS BEEN COMPLETED. FIRST SET IS FOR FORWARD ORIENTATION ANGLE OF CONCERN. RESETTING OF ISAMP TO 0 BY PROGRAM STATEMENT 5000 IS NECESSARY BEFORE SIMULATION OF ENGAGEMENTS FOR REVERSE ANGLE CAN BEGIN. IF ISPLIT EQUALS 2 OR 3, NEND1 ENGAGEMENTS HAVE ALREADY BEEN SIMULATED FOR BOTH FORWARD AND REVERSE ANGLES. IF NECESSARY, RESET ISAMP TO NEND1 BEFORE NEXT SET OF ENGAGEMENTS IS INITIATED.

576 BASIC ADJUSTMENT PROCEDURE DOES NOT INVOLVE PROGRAM LINES 577 AND 578.

577- 578 INITIAL SETTINGS.

580 NSMDTR EQUALLING 0 INDICATES PROGRAM LINES 581 THROUGH 585 ARE TO BE SKIPPED.

581- 585 INITIAL SETTINGS.

587 PROGRAM LINES 588 THROUGH 643 ARE OF POSSIBLE CONCERN FOR FORWARD ORIENTATION ANGLE OF TARGET BUT NOT FOR REVERSE ANGLE.

588 PROGRAM LINES 589 THROUGH 597 ARE NEVER INVOLVED AFTER PROCESSING FOR FIRST PAIR OF TARGET ORIENTATION ANGLES HAS BEEN COMPLETED.

589- 597 ENGAGEMENT IS TO BE REPEATEDLY SIMULATED TOTAL OF NSAMP TIMES FOR EACH SET OF CONDITIONS. EACH SIMULATED ENGAGEMENT IS CALLED SAMPLE ENGAGEMENT OR SIMPLY

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      IF ( ISPLIT .EQ. 1 ) GO TO 5000
      IF ( ISPLIT .EQ. 2 ) GO TO 5100
      ISAMP = NEND1
      GO TO 5100
575 4300 CONTINUE
      IF ( NADJST .EQ. 0 ) GO TO 4305
      DO 4310 I = 1,NRDS
 4310 AFAIL(I) = 0.0
 4305 CONTINUE
580   IF ( NSMDTR .EQ. 0 ) GO TO 4400
      DO 4320 N = 1,5
      DO 4320 I = 1,2
      DO 4320 J = 1,50
      NMINUS(J,I,N) = 0
585 4320 NPLUS(J,I,N) = 0
 4400 CONTINUE
      IF ( NBETA .EQ. NANGLE ) GO TO 5000
      IF ( NANGLE .GT. 1 ) GO TO 4500
      NSAMP = 10000
590   SAMP = NSAMP
      WRITE ( 6,4410) NSAMP
 4410 FORMAT ( / /, 10X,21H NUMBER OF SAMPLES = ,I6 )
      IF ( NSTCRD .GT. 0 ) GO TO 4415
      IF ( INTPL .EQ. 1 ) GO TO 4425
595 4415 NEND1 = NSAMP
      GO TO 4500
 4425 IF ( NANGLE .EQ. 1 ) NEND1 = RATIO * SAMP
 4500 CONTINUE
      IF ( NSTCRD .GT. 0 ) GO TO 4600
600   IF ( NRANGE .GT. 1 ) GO TO 4600
      IF ( NANGLE .GT. 1 ) GO TO 4600
      DROP = 0.0
      IF ( NDROP .EQ. 0 ) GO TO 4600
      IF ( NDROP .GT. 1 ) GO TO 4510
605   DROP = (YTOP-YBASE) * 0.5
      GO TO 4600
 4510 IF ( NADJST .NE. 2 .AND. NADJST .NE. 4 ) GO TO 4600
      PI = 3.14159
      R = IRANGE
610   CNMTER = R*PI / 3200.0
      CNINCH = CNMTER * 39.37
      IF ( NDROP .GT. 2 ) GO TO 4520
      DROP = 0.5 * CNINCH
      GO TO 4600
615 4520 IF ( NDROP .GT. 3 ) GO TO 4530
      DROP = 1.0 * CNINCH
      GO TO 4600
 4530 IF ( NDROP .GT. 4 ) GO TO 4540
      DROP = 2.0 * CNINCH
620   GO TO 4600
 4540 IF ( NDROP .GT. 5 ) GO TO 4550
      DFLCTN = 1.0 * CNINCH
      GO TO 4600
 4550 IF ( NDROP .GT. 6 ) GO TO 4560
625   DFLCTN = 2.5 * CNINCH
      GO TO 4600
 4560 DFLCTN = 5.0 * CNINCH
```

SAMPLE IN THESE EXPLANATIONS. SAMP IS REAL FORM. NEND1 REPRESENTS NUMBER OF ENGAGEMENTS THAT REQUIRE CONSIDERATION AS PART OF FIRST, AND POSSIBLY ONLY, GROUP PROCESSED. NEND1 IS SET EITHER TO NSAMP OR, IF RANGE INTERPOLATION OF TARGET VULNERABILITY DATA IS INVOLVED, TO APPROPRIATE FRACTION OF NSAMP. IN LATTER CASE PROGRAM STATEMENT 6015 SUBSEQUENTLY CAUSES REMAINING PORTION OF NSAMP ENGAGEMENTS TO BE ACCOUNTED FOR.

599- 601 PROGRAM LINES 602 THROUGH 627 CAN BE OF CONCERN ONLY WHEN FIRST RANGE AND FIRST PAIR OF TARGET ORIENTATION ANGLES ARE BEING PROCESSED. CONDITION INVOLVING NSTCRD IS INCLUDED BECAUSE SPECIAL SETTINGS OF NANGLE AND NBETA ESTABLISHED BY PROGRAM LINES 536 AND 537 WHEN RUN INVOLVES TARGET SHAPE DATA FROM CARDS WOULD OTHERWISE CAUSE PROBLEM.

602 INITIAL SETTING.

603 SKIP PROGRAM LINES 604 THROUGH 627 IF NDROP IS 0.

604- 627 RESET STANDARD VERTICAL ADJUSTMENT DROP TO HALF OF TARGET HEIGHT FOR NDROP EQUALLING 1. NDROP VALUES 2 THROUGH 6 ARE ASSOCIATED WITH NADJST EQUALLING 2 THROUGH 5. IGNORE CORRESPONDING PROGRAM STATEMENTS.

629- 634 INITIAL SETTINGS.

635- 643 CONDITIONS OF INTEREST INCLUDE PAIR OF TARGET ORIENTATION ANGLES REPRESENTED BY NANGLE AND NPVRSE OR PARTICULAR TARGET ASSOCIATED WITH NTRGTC.

644 INITIAL SETTING BEFORE ANY SAMPLE ENGAGEMENTS FOR PARTICULAR CONDITIONS.

645- 892 CYCLE FOR EACH SAMPLE ENGAGEMENT SIMULATED.

645- 653 INITIAL SETTINGS FOR PARTICULAR SAMPLE ENGAGEMENT BEING SIMULATED.

654- 656 R1 AND R2 ARE RANDOM NORMAL DEVIATES DRAWN FROM NORMAL DISTRIBUTION WITH MEAN OF 0 AND STANDARD DEVIATION OF 1. CALCULATED VALUES OF XC1 AND YC1 ARE COORDINATES OF POINT IN TARGET COORDINATE SYSTEM WHERE FIRST ROUND WOULD IMPACT IF THERE WERE NO RANDOM ERRORS. XC1 IS SUM OF 1) HORIZONTAL COORDINATE XC OF INTENDED AIMPOINT, 2) HORIZONTAL FIXED BIAS XB, AND 3) HORIZONTAL VARIABLE BIAS DETERMINED FOR PARTICULAR FIRING ENGAGEMENT OF CONCERN BY APPLYING R1 AS ADJUSTMENT FACTOR TO VARIABLE BIAS STANDARD DEVIATION SIGXB. SIMILARLY FOR YC1.

657- 658 INITIAL SETTINGS.

659- 891 CYCLE FOR EACH ROUND FIRED.

659- 660 INITIAL SETTINGS.

661- 669 COORDINATES X1 AND Y1 OF ROUND IMPACT POINT IN PLANE OF TARGET ARE DETERMINED. FAC IS CONTROL THAT CAN EQUAL ONLY 0 OR 1. FAC IS INITIALLY SET TO 1 TO INDICATE THAT NO ADJUSTMENT BASED ON SENSING HAS YET OCCURRED, AND RESET TO 0 AFTER FIRST SUCH ADJUSTMENT. LAY ERRORS ARE EXCLUDED FROM FURTHER CONSIDERATION WHEN ADJUSTMENT BASED ON SENSING HAS BEEN MADE, BECAUSE ASSOCIATED SENSING ERRORS ARE DEFINED TO INCLUDE LAY ERRORS AS WELL AS ROUND OBSERVATION ERRORS. HORIZONTAL LAY ERROR X2, IF APPLICABLE, IS GOTTEN BY APPLYING R1 TO HORIZONTAL LAY ERROR STANDARD DEVIATION SIGXL. SIMILARLY FOR VERTICAL LAY ERROR Y2. HORIZONTAL RANDOM ERROR XRE ACCOUNTS FOR LAY ERROR, IF NECESSARY, AND ALWAYS INCLUDES HORIZONTAL ROUND-TO-ROUND ERROR DETERMINED, FOR SPECIFIC ROUND BEING CONSIDERED, BY APPLYING R1 TO HORIZONTAL ROUND-TO-ROUND STANDARD DEVIATION SIGXR. SIMILARLY FOR VERTICAL RANDOM ERROR YRE. COORDINATES X1 AND Y1 OF ACTUAL IMPACT POINT ARE OBTAINED BY ADJUSTING XC1 AND YC1 TO REFLECT CONTRIBUTION OF RANDOM ERRORS.

```
      4600 CONTINUE
           DO 4610 J = 1,10
630        DO 4610 I = 1,61
      4610 AKIL(I,J) = 0.0
           DO 4620 J = 1,12
           DO 4620 I = 1,NRDS
      4620 Z(I,J) = 0.0
635        IF ( NSTCRD .GT. 0 ) GO TO 4640
           NRVRSE = NANGLE + 1
           WRITE ( 6,4630 ) NANGLE,NRVRSE
      4630 FORMAT ( / /, 10X,10H ANGLES = ,2I7 )
           WRITE ( 6,1020 )
640        GO TO 5000
      4640 WRITE ( 6,4650 ) NTRGTC
      4650 FORMAT ( / /, 10X,10H TARGET = ,I7 )
           WRITE ( 6,1020 )
      5000 ISAMP = 0
645   5100 ISAMP = ISAMP + 1
           T = FLT
           SUMCASE = 0.0
           XC1 = 0.0
           YC1 = 0.0
650        IHW = 0
           NFAIL = 0
           DO 5110 J = 1,10
      5110 C(J) = 0.0
           CALL NRAN(R1,R2)
655        XC1 = XC1 + XC + XB + R1*SIGXB
           YC1 = YC1 + YAIM + YB + R2*SIGYB
           FAC = 1.0
           J = 0
      5200 J = J + 1
660        NSHORT = 0
           IF ( FAC .EQ. 0.0 ) GO TO 5205
           CALL NRAN(R1,R2)
           X2 = R1 * SIGXL
           Y2 = R2 * SIGYL
665   5205 CALL NRAN(R1,R2)
           XRE = FAC*X2 + R1*SIGXR
           YRE = FAC*Y2 + R2*SIGYR
           X1 = XC1 + XRE
           Y1 = YC1 + YRE
670        CALL NRAN(T1,T2DUM)
           IF ( J .GT. 1 ) GO TO 5215
           HWM = XM1 * EXP(T1*STD1)
           IF ( HWM .LT. AMT1 ) HWM = AMT1
           T = T + TF1 + HWM
675        GO TO 5220
      5215 HWM = XM2 * EXP(T1*STD2)
           IF ( HWM .LT. AMT2 ) HWM = AMT2
           T = T + TFS + HWM
      5220 CONTINUE
680        J10 = 2.0 + T/2.0
           IF ( NADJST .LT. 2 .OR. NADJST .GT. 5 ) GO TO 5225
           IF ( WCELL .EQ. 100.0 .AND. YBASE .GT. 0.0 ) GO TO 5235
           IF ( XLEFTF(IC) .LE. X1 .AND. X1 .LE. XRGHTF(IC) ) GO TO 5245
           IF ( NADJST .EQ. 2 .OR. NADJST .EQ. 3 ) GO TO 5665
```

670- 678 ENGAGEMENT TIME T IS RESET TO EQUAL TIME AT WHICH ROUND UNDER CONSIDERATION REACHES TARGET RANGE. SECOND RANDOM NORMAL DEVIATE T2DUM IS UNNEEDED AND IGNORED. DISTINCTION IS MADE BETWEEN FIRST ROUND AND SUBSEQUENT ROUNDS. FIRST ROUND FIRING TIME, MEASURED FROM BEGINNING OF ENGAGEMENT, INCLUDES FIXED TIME COMPONENT TF1 THAT MAY EQUAL 0. VARIABLE COMPONENT, WHICH IS TOTAL FIRING TIME IF FIXED TIME EQUALS 0, IS GOTTEN FROM LOGARITHMICONORMAL DISTRIBUTION WITH MEDIAN TIME XM1 AND VARIABILITY FACTOR ST1. HWM REPRESENTS SPECIFIC VARIABLE TIME GENERATED FROM DISTRIBUTION OF TIMES BY APPLICATION OF T1. IF INITIAL VALUE OF HWM IS EVER LESS THAN MINIMUM TIME AMT1, LATTER VALUE OVERRIDES. UPDATED VALUE OF T IS TIME AT WHICH FIRST ROUND HITS OR MISSES TARGET, BECAUSE FLIGHT TIME FLT HAS ALREADY BEEN ACCOUNTED FOR BY INITIAL SETTING. NOTE THAT PROGRAM DOES NOT PROCESS FLIGHT TIME AND FIRING TIME OF FIRST ROUND IN ORDER MATCHING CHRONOLOGICAL SEQUENCE OF BATTLE EVENTS, SINCE FIRING OF ROUND OBVIOUSLY PRECEDES ITS FLIGHT TOWARD TARGET. FIRING TIME FOR EACH SUBSEQUENT ROUND IS ESTABLISHED BASICALLY LIKE FIRST ROUND FIRING TIME. EACH SUBSEQUENT ROUND FIRING TIME IS CONSIDERED MEASURED FROM TIME AT WHICH PREVIOUS ROUND IS FIRED. SUBSEQUENT ROUND FIRING TIME ACCOUNTS FOR FIXED TIME COMPONENT THAT MAY AGAIN BE 0. VARIABLE TIME COMPONENT, WHICH MAY BE TOTAL FIRING TIME, IS GOTTEN FROM LOGARITHMICONORMAL DISTRIBUTION WITH MEDIAN TIME XM2 AND VARIABILITY FACTOR ST2. HWM REPRESENTS SPECIFIC VARIABLE TIME BASED ON T1. IF NECESSARY, INITIAL VALUE OF HWM IS OVERRIDDEN BY MINIMUM TIME AMT2. UPDATED VALUE OF T IS TIME AT WHICH SUBSEQUENT ROUND OF INTEREST HITS OR MISSES TARGET. ANOTHER OBSERVATION IS USEFUL. SUPPOSE, FOR EXAMPLE, THAT FOURTH ROUND IS BEING PROCESSED. VALUE OF T PRIOR TO UPDATING IS TIME AT WHICH THIRD ROUND HITS OR MISSES TARGET. STRICTLY SPEAKING, ONE NEEDS TO SUBTRACT PROJECTILE FLIGHT TIME TO GET TIME AT WHICH THIRD ROUND IS FIRED, ADD FOURTH ROUND FIRING TIME, AND THEN ADD TIME OF FLIGHT FOR FOURTH ROUND. FIRST AND THIRD OF THESE STEPS CLEARLY CANCEL EACH OTHER OUT AND ARE CONSEQUENTLY NOT EXPLICITLY REQUIRED.

680 TIME T IS CONVERTED TO INDEX J10 ASSOCIATED WITH AKIL ARRAY. J10 EQUALLING 1 IS RESERVED FOR 0 SECONDS, RATHER THAN FOR ANY INTERVAL. SUBSEQUENT INTEGER VALUES OF J10 CORRESPOND TO TIME INTERVALS OF 0 TO 2 SECONDS (EXCLUDING BOTH 0 AND 2 SECONDS), 2 TO 4 SECONDS (EXCLUDING 4 SECONDS), ETC . . ., RESPECTIVELY. ASSUME, FOR EXAMPLE, THAT T EQUALS 47.8 SECONDS. THEN, T/2 EQUALS 23.9, AND 23.9 + 2 EQUALS 25.9. SINCE J10 IS INTEGER QUANTITY, IT IS SET TO 25.

681- 694 IGNORE THESE SPECIAL STATEMENTS FOR NADJST EQUALLING 2 THROUGH 5.

696- 710 DETERMINE WHETHER ROUND HITS TARGET.

696- 701 ANY ROUND FOR WHICH VERTICAL COORDINATE OF IMPACT POINT IS LESS THAN VERTICAL COORDINATE YBASE DEFINING TARGET BASE MISSES TARGET. WHEN NADJST EQUALS 1, NSHORT IS SET TO 1 TO INDICATE THAT PARTICULAR MISSING ROUND UNDER CONSIDERATION HAS BEEN SHORT OF TARGET. FIRE ADJUSTMENT PROCEDURE ASSOCIATED WITH NADJST EQUALLING 0 DOES NOT INVOLVE DISTINGUISHING WHETHER MISSING ROUND IS SHORT OR NOT.

703 IGNORE.

704 HORIZONTAL COORDINATE OF IMPACT POINT IS SMALLER THAN SMALLEST X COORDINATE ASSOCIATED WITH VERTICAL RECTANGLE ENCLOSING TARGET. ROUND MISSES TO LEFT.

705 ROUND MISSES TO RIGHT.

706 ROUND IS TOO LOW TO HIT TARGET. ALTHOUGH COMPARISON INVOLVING YBASE HAS BEEN MADE EARLIER, IT IS POSSIBLE YBASE AND AY(1)-H DIFFER SLIGHTLY DUE TO ROUNDING.

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685                 IF ( NADJST .EQ. 5 ) GO TO 5625
                    IF ( X1 .LT. XLEFTF(IC) ) XC1 = XC1 + DFLCTN
                    IF ( X1 .GT. XRGHTF(IC) ) XC1 = XC1 - DFLCTN
                    GO TO 5800
                5235 IF ( XLEFTD(IC) .LE. X1 .AND. X1 .LE. XRGHTD(IC) ) GO TO 5245
690                 IF ( NADJST .EQ. 2 .OR. NADJST .EQ. 3 ) GO TO 5665
                    IF ( NADJST .EQ. 5 ) GO TO 5625
                    IF ( X1 .LT. XLEFTD(IC) ) XC1 = XC1 + DFLCTN
                    IF ( X1 .GT. XRGHTD(IC) ) XC1 = XC1 - DFLCTN
                    GO TO 5800
695             5225 CONTINUE
                    IF ( NADJST .EQ. 1 ) GO TO 5255
                    IF ( Y1 .LT. YBASE ) GO TO 5600
                    GO TO 5245
                5255 IF ( Y1 .GE. YBASE ) GO TO 5245
700                 NSHORT = 1
                    GO TO 5600
                5245 CONTINUE
                    IF ( NADJST .EQ. 4 .OR. NADJST .EQ. 5 ) GO TO 5400
                    IF ( X1 .LT. AX(1)-H ) GO TO 5600
705                 IF ( X1 .GT. AX(NX)+H ) GO TO 5600
                    IF ( Y1 .LT. AY(1)-H ) GO TO 5600
                    IF ( Y1 .GT. AY(NY)+H ) GO TO 5600
                    JV = MIN1((Y1-AY(1)+H)/W + 1.0,CNY)
                    IH = MIN1((X1-AX(1)+H)/W + 1.0,CNX)
710                 IF ( IK(JV,IH) .LE. 0 ) GO TO 5600
                    IF ( J .GT. 1 ) GO TO 5265
                    IF ( INTPL .EQ. 1 ) GO TO 5265
                    IF ( NDTRM1 .EQ. 0 .AND. NDTRM2 .EQ. 0 ) GO TO 5265
                    COORD(1) = X1 - XRE - XC
715                 COORD(2) = Y1 - YRE - YC
                    DO 5270 I = 1,2
                    IF ( COORD(I) .GE. 0.0 ) GO TO 5275
                    NCOORD = -COORD(I)/20.0 + 1.0
                    IF ( NCOORD .GT. 50 ) NCOORD = 50
720                 DO 5280 N = 1,2
                    IF ( KDMSTC(N) .EQ. 0 ) GO TO 5280
                    NMINUS(NCOORD,I,N) = NMINUS(NCOORD,I,N) + 1
                5280 CONTINUE
                    GO TO 5270
725             5275 NCOORD = COORD(I)/20.0 + 1.0
                    IF ( NCOORD .GT. 50 ) NCOORD = 50
                    DO 5290 N = 1,2
                    IF ( KDMSTC(N) .EQ. 0 ) GO TO 5290
                    NPLUS(NCOORD,I,N) = NPLUS(NCOORD,I,N) + 1
730             5290 CONTINUE
                5270 CONTINUE
                5265 CONTINUE
                    IF ( RANF(DUM) .GT. RELT ) GO TO 5700
                    IF ( NHIT .EQ. 0 ) GO TO 5400
735                 CALL NRAN(R1,R2)
                    XC1 = XC1 - X1 + XC - R1*HSX
                    YC1 = YC1 - Y1 + YC - R2*HSY
                    FAC = 0.0
                5400 CONTINUE
740                 IF (IHW .GT. 0 ) GO TO 5405
                    IHW = 1
```

707 ROUND MISSES HIGH.

708- 710 ROUND HITS WITHIN RECTANGLE ENCLOSING TARGET. IMPACT POINT IS WITHIN CELL WHOSE CENTER HAS Y AND X COORDINATES EQUAL TO JV AND IH RESPECTIVELY. FORMULAS FOR JV AND IH SYSTEMATICALLY RESOLVE AMBIGUITIES THAT ARISE, EXCEPTIONALLY, IF IMPACT POINT IS COMMON TO TWO OR FOUR CELLS. FOLLOWING ILLUSTRATION SHOULD CLARIFY FORMULA FOR JV. 1) Y1-(AY(1)-H), WHICH EQUALS Y1-AY(1)+H, IS DISTANCE IN INCHES FROM IMPACT POINT TO BOTTOM EDGE OF RECTANGLE. LET THIS DISTANCE EQUAL 22.415 INCHES. 2) DIVISION BY CELL DIMENSION W CONVERTS FROM INCHES TO CORRESPONDING NUMBER OF CELLS. LET W EQUAL 3.937 INCHES. THEN 22.415 INCHES EQUAL 5.693 CELLS. 3) FOR EXAMPLE CHOSEN, IMPACT POINT OBVIOUSLY LIES IN SIXTH ROW OF CELLS. SINCE JV IS INTEGER QUANTITY, ANY DECIMAL FRACTION SUCH AS .693 IS EVENTUALLY DROPPED FROM CALCULATION AND ADDITION OF 1 TO GET 6.693 IS NECESSARY. INTEGER VALUE 6 FOR JV IS OBTAINED BY DROPPING .693. COMPARISON OF 6.693 TO CNY ENSURES THAT MAXIMUM POSSIBLE VALUE NY IS NEVER EXCEEDED DUE TO ROUNDING. SIMILAR EXPLANATIONS APPLY TO IH. PREVIOUS PROCESSING OF TARGET DESCRIPTION AND VULNERABILITY DATA HAS SET IK ARRAY VALUES TO BE POSITIVE IF AND ONLY IF CORRESPONDING CELLS ARE INCLUDED IN TARGET. ROUND MISSES IF IT IMPACTS ON CELL WHICH, ALTHOUGH IN RECTANGLE ENCLOSING TARGET, IS NOT PART OF TARGET.

711- 713 PROGRAM LINES 714 THROUGH 731 INVOLVE SPECIAL CALCULATIONS ASSOCIATED WITH AT LEAST ONE OF CONTROLS NDTRM1 AND NDTRM2 EQUALLING 1. THESE CALCULATIONS CANNOT BE ATTEMPTED IF ROUND INDEX J INDICATES THAT SOME SUBSEQUENT ROUND RATHER THAN FIRST ROUND IS BEING PROCESSED OR IF RANGE INTERPOLATION OF TARGET VULNERABILITY DATA IS NEEDED.

714- 715 COORD(1) AND COORD(2) RESPECTIVELY ARE ESSENTIALLY HORIZONTAL AND VERTICAL MISS DISTANCES IN TARGET PLANE WITH REFERENCE TO APPROXIMATE CENTER OF MASS OF TARGET. TO VERIFY THIS, SEE HOW XC1 AND YC1 ARE CALCULATED BY PROGRAM LINES 655 AND 656 AND HOW X1 AND Y1 ARE SET BY LINES 668 AND 669. COORD(1) IS DIFFERENCE BETWEEN X COORDINATE OF APPROXIMATE CENTER OF MASS AND X COORDINATE OF POINT THAT WOULD BE HIT REPEATEDLY IF THERE WERE NO RANDOM ERRORS AND WEAPON FIRED SEVERAL ROUNDS WITHOUT ANY ADJUSTMENT BETWEEN ROUNDS. SIMILARLY, COORD(2) IS DIFFERENCE OF CORRESPONDING Y COORDINATES.

716- 731 INDEX I VALUES 1 AND 2 ARE ASSOCIATED WITH PROCESSING OF HORIZONTAL AND VERTICAL MISS DISTANCES RESPECTIVELY. PROGRAM LINES 718 THROUGH 723 APPLY TO NEGATIVE COORD(I) VALUES, WHILE LINES 725 THROUGH 730 COVER POSITIVE VALUES OR 0. QUANTITIES IN NMINUS AND NPLUS ARRAYS ARE COUNTERS INDICATING NUMBERS OF ENGAGEMENTS FOR WHICH MISS DISTANCE FALLS WITHIN ANY 20-INCH INTERVAL. TOTAL SPREAD COVERED IS BASICALLY FROM -1000.0 TO 1000.0 (EXCLUDING -1000.0 AND 1000.0) INCHES. ANY MISS DISTANCE OUTSIDE THIS SPREAD WOULD BE COUNTED AS BEING WITHIN INTERVAL NUMBER 50 ASSOCIATED WITH NMINUS OR NPLUS ARRAY. N EQUALLING 1 CORRESPONDS TO ALL FIRST ROUNDS THAT HIT TARGET. CALCULATIONS FOR N EQUAL TO 2 ARE IDENTICAL AT THIS STAGE TO THOSE FOR N EQUAL TO 1 BUT EVENTUALLY APPLY TO FIRST ROUND HITS THAT DO NOT RESULT IN K (COMPLETE DESTRUCTION) KILL OF TARGET.

733 RANDOM NUMBER RANF(DUM) IS COMPARED TO PROBABILITY RELT THAT ROUND HAS FLOWN RELIABLY TO TARGET RANGE. DEFECTS CAUSING ERRATIC FLIGHT OF ROUND ARE CONSIDERED TO MAKE IT IMPOSSIBLE FOR ROUND TO HIT AND FOR FIRE ADJUSTMENT TO BE ATTEMPTED. PROCESSING CONTINUES AT PROGRAM STATEMENT 5700 AFTER DETERMINATION OF DEFECTIVE TRAJECTORY.

734 SKIP PROGRAM LINES 735 THROUGH 738 IF NHIT CONTROL INDICATES AIMPOINT IS NOT TO BE ADJUSTED AFTER TARGET HIT.

735- 738 ADJUSTMENT OF AIMPOINT AFTER TARGET HIT IS CONSIDERED BASED ON GUNNER SENSING OF IMPACT. UPDATED VALUES OF XC1 AND YC1 ARE COORDINATES OF POINT IN TARGET COORDINATE SYSTEM WHERE NEXT ROUND WOULD IMPACT IF THERE WERE NO RANDOM

ERRORS. XC1 IS OBTAINED BY COMBINING 1) HORIZONTAL COORDINATE XC OF INTENDED AIMPOINT, 2) DIFFERENCE XC1-X1 WHICH INVOLVES XC1 AND X1 VALUES FROM EARLIER CALCULATIONS AND WHICH, AS CAN BE SEEN FROM PROGRAM LINE 668, CAUSES SPECIFIC HORIZONTAL RANDOM ERRORS THAT AFFECTED IMPACT POINT OF HITTING ROUND TO BE REMOVED, AND 3) ADJUSTMENT ERROR OBTAINED BY APPLYING R1 TO HORIZONTAL STANDARD DEVIATION HSX. TERM ACCOUNTING FOR ADJUSTMENT ERROR INVOLVES MINUS SIGN BECAUSE, IF HITTING ROUND IS JUDGED TO BE OFF TARGET CENTER IN ONE DIRECTION, WEAPON IS MOVED IN OPPOSITE DIRECTION. FORMULA FOR YC1 OBVIOUSLY PARALLELS THAT FOR XC1. FAC IS RESET SO THAT LAY ERRORS, CONSIDERED INCLUDED AS PART OF ADJUSTMENT ERRORS, WILL NO LONGER BE TREATED EXPLICITLY.

740– 741 IF IHW EQUALS 0, RESET TO 1. IHW CAN BE ONLY 0 OR 1, LATTER INDICATING THAT TARGET HAS BEEN HIT AT LEAST ONCE IN PARTICULAR SAMPLE ENGAGEMENT UNDER CONSIDERATION. ONCE IHW IS SET TO 1, IT REMAINS UNCHANGED FOR REMAINDER OF ENGAGEMENT.

742– 748 UPDATE Z AND AKIL ARRAYS TO ACCOUNT FOR TARGET HIT BEING PROCESSED. SET INDEX KH TO 5 FOR 0, 30, 60, OR 90 DEGREES OR TO 10 FOR REVERSE ANGLE MATCHED WITH EACH FIRST ANGLE. EACH Z(K,5) OR Z(K,10) VALUE REPRESENTS HOW MANY TIMES FIRST TARGET HIT OCCURRED EITHER ON ROUND K OR ON EARLIER ROUND IN SAMPLE ENGAGEMENTS PROCESSED SO FAR. INDEX J10 ASSOCIATED WITH AKIL ARRAY IS RESTRICTED AT THIS POINT TO MAXIMUM VALUE OF 61 TO PRECLUDE FURTHER CONSIDERATION OF HITS THAT OCCUR AT TIMES EQUALLING OR EXCEEDING LIMIT OF 120 SECONDS (2 MINUTES). AKIL ARRAY IS UPDATED TO ACCOUNT FOR TIME AT WHICH HIT UNDER CONSIDERATION OCCURS. EACH AKIL(K,5) OR AKIL(K,10) VALUE REPRESENTS HOW MANY TIMES TARGET HAS BEEN HIT AT LEAST ONCE PRIOR TO TIME EQUALLING 2(K-1) SECONDS IN SAMPLE ENGAGEMENTS PROCESSED SO FAR. ANY PARTICULAR ENGAGEMENT DOES NOT CONTRIBUTE TO AKIL(K,5) OR AKIL(K,10) VALUE IF TARGET IS NOT HIT AT ALL OR IF IT IS FIRST HIT AT TIME EQUALLING OR EXCEEDING 2(K-1) SECONDS.

749 SKIP PROGRAM LINES 750 THROUGH 891 IF NPRHIT INDICATES TARGET HIT ONLY IS OF CONCERN BUT KILLS ARE NOT. ENGAGEMENT IS OVER SINCE FIRST HIT ON TARGET HAS BEEN ACHIEVED.

750 IT IS CONSIDERED THAT TARGET CANNOT BE KILLED IF, FOR ROUNDS WITH FUZE, LATTER DOES NOT PERFORM RELIABLY WHEN TARGET IS HIT. INPUT PROBABILITY RELF IS SIMPLY SET EQUAL TO 1.0000 FOR ANY ROUND TYPE THAT DOES NOT INVOLVE FUZING. PROCESSING CONTINUES AT PROGRAM STATEMENT 5700 AFTER DETERMINATION OF DEFECTIVE FUZE FUNCTIONING.

751– 784 KILLING EFFECTS THAT RESULT FROM TARGET BEING HIT BY PARTICULAR ROUND OF CONCERN, EXCEPT FOR PASSENGER PERSONNEL CASUALTIES CONSIDERED LATER, ARE DETERMINED.

751– 753 INITIAL SETTINGS. HW2 IS USED FOR TEMPORARY STORAGE OF RANDOM NUMBER NEEDED SUBSEQUENTLY TO DETERMINE WHETHER OR NOT TARGET IS KILLED AS RESULT OF BEING HIT. K22 IS USED FOR TEMPORARY STORAGE OF IK(JV,IH) VALUE ASSOCIATED WITH TARGET CELL HIT. N IS INVOLVED IN UNPACKING OF ARRAY MPK QUANTITIES.

754– 772 UNPACK MPK ARRAY QUANTITY THAT CORRESPONDS TO TARGET CELL HIT AND ASSOCIATED TARGET ORIENTATION TO RETRIEVE PROBABILITIES OF M KILL, F KILL, M OR F KILL, AND K KILL PER HIT AND, IF NECESSARY, EXPECTED CASUALTIES PER HIT. STORE THESE IN PK ARRAY, USING PK(1) OR PK(6) FOR M KILL PROBABILITY, PK(2) OR PK(7) FOR F KILL PROBABILITY, PK(3) OR PK(8) FOR M OR F KILL PROBABILITY, PK(4) OR PK(9) FOR K KILL PROBABILITY, AND PK(5) OR PK(10) FOR CASUALTIES. PK(1) THROUGH PK(5) ARE USED FOR TARGET ORIENTATION ANGLE OF 0, 30, 60, OR 90 DEGREES, AND PK(6) THROUGH PK(10) FOR CORRESPONDING REVERSE ANGLE.

773– 784 CONSIDER KILL CRITERIA IN TURN. INDEX K21 EQUALS 1 OR 6 FOR M KILL, 2 OR 7 FOR

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                      KH = 5
                      IF ( NBETA .EQ. NANGLE ) KH = 10
                      DO 5410 K = J,NRDS
745             5410  Z(K,KH) = Z(K,KH) + 1.0
                      IF ( J10 .GT. 61 ) GO TO 5405
                      DO 5420 K = J10,61
                5420  AKIL(K,KH) = AKIL(K,KH) + 1.0
                5405  IF ( NPRHIT .EQ. 1 ) GO TO 6000
750                   IF ( RANF(DUM) .GT. RELF ) GO TO 5700
                      HW2 = RANF(DUM)
                      K22 = IK(JV,IH)
                      N = -49
                      DO 5430 K = 1,4
755                   IF ( NBETA .EQ. NANGLE ) GO TO 5435
                      IST = SHIFT(MPK(K22,IA),N) .AND. MASK11
                      ST = IST
                      PK(K) = 0.001 * ST
                      GO TO 5430
760             5435  IST1 = SHIFT(MPK(K22,IB),N) .AND. MASK11
                      ST1 = IST1
                      PK(K+5) = 0.001 * ST1
                5430  N = N + 11
                      IF ( NBETA .EQ. NANGLE ) GO TO 5445
765                   IST = MPK(K22,IA) .AND. MASK16
                      ST = IST
                      PK(5) = 0.001 * ST
                      GO TO 5450
                5445  IST1 = MPK(K22,IB) .AND. MASK16
770                   ST1 = IST1
                      PK(10) = 0.001 * ST1
                5450  CONTINUE
                      DO 5460 KILL = 1,4
                      K21 = KILL
775                   IF ( NBETA .EQ. NANGLE ) K21 = K21+5
                      IF ( C(K21) .GT. 0.0 ) GO TO 5460
                      IF ( PK(K21) .LT. HW2 ) GO TO 5460
                      C(K21) = 1.0
                      DO 5490 K = J,NRDS
780             5490  Z(K,K21) = Z(K,K21) + 1.0
                      IF ( J10 .GT. 61 ) GO TO 5460
                      DO 5480 K = J10,61
                5480  AKIL(K,K21) = AKIL(K,K21) + 1.0
                5460  CONTINUE
785                   IF ( J .GT. 1 ) GO TO 5505
                      IF ( INTPL .EQ. 1 ) GO TO 5505
                      IF ( NDTRM2 .EQ. 0 ) GO TO 5505
                      KKILL = 4
                      IF ( NBETA .EQ. NANGLE ) KKILL = KKILL + 5
790                   IF ( C(KKILL) .EQ. 0.0 ) GO TO 5505
                      N = 2
                      COORD(1) = X1 - XRE - XC
                      COORD(2) = Y1 - YRE - YC
                      DO 5510 I = 1,2
795                   IF ( COORD(I) .GE. 0.0 ) GO TO 5515
                      NCOORD = -COORD(I)/20.0 + 1.0
                      IF ( NCOORD .GT. 50 ) NCOORD = 50
                      NMINUS(NCOORD,I,N) = NMINUS(NCOORD,I,N) - 1
```

F KILL, 3 OR 8 FOR M OR F KILL, AND 4 OR 9 FOR K KILL. VALUES 1 THROUGH 4 APPLY TO TARGET ORIENTATION ANGLES OF 0, 30, 60, AND 90 DEGREES, WHILE 6 THROUGH 9 APPLY FOR ASSOCIATED REVERSE ANGLES. EACH QUANTITY IN C ARRAY CAN BE ONLY 0 OR 1, LATTER VALUE INDICATING TARGET HAS BEEN KILLED FOR ANGLE UNDER CONSIDERATION AND KILL CRITERION CORRESPONDING TO K21. NO FURTHER PROCESSING IS TO BE DONE FOR PARTICULAR ANGLE AND CRITERION WHEN RELATED C VALUE ALREADY EQUALS 1. IF TARGET KILL HAS NOT ALREADY BEEN ACHIEVED BY EARLIER ROUND, FOR SPECIFIC COMBINATION OF ANGLE AND CRITERION, RANDOM NUMBER HW2 AND APPLICABLE KILL PROBABILITY PK(K21) ARE COMPARED TO DETERMINE WHETHER TARGET IS KILLED. IF TARGET KILL IS ACHIEVED, RESET C(K21) AND UPDATE Z AND AKIL ARRAYS ACCORDINGLY. Z AND AKIL ARRAY UPDATING IS VERY SIMILAR TO THAT ALREADY EXPLAINED FOR PROGRAM LINES 742 THROUGH 748. EACH Z(K,K21) VALUE REPRESENTS HOW MANY TIMES TARGET ORIENTED AS INDICATED BY K21 HAS BEEN KILLED ACCORDING TO CRITERION ASSOCIATED WITH K21 EITHER ON ROUND K OR ON EARLIER ROUND IN SAMPLE ENGAGEMENTS PROCESSED SO FAR. EACH AKIL(K,K21) VALUE REPRESENTS HOW MANY TIMES TARGET HAS BEEN KILLED PRIOR TO TIME EQUALLING 2(K-1) SECONDS.

785- 787 PROGRAM LINES 788 THROUGH 803 INVOLVE SPECIAL CALCULATIONS ASSOCIATED WITH NDTRM2 EQUALLING 1. THESE CALCULATIONS CANNOT BE ATTEMPTED IF ROUND INDEX J INDICATES THAT SOME SUBSEQUENT ROUND RATHER THAN FIRST ROUND IS BEING PROCESSED OR IF RANGE INTERPOLATION OF TARGET VULNERABILITY DATA IS NEEDED.

788- 790 SET KKILL TO EQUAL 4 FOR FORWARD ANGLE OR 9 FOR REVERSE ANGLE. IF C(KKILL) INDICATES K KILL OF TARGET HAS NOT BEEN ACHIEVED, SKIP PROGRAM LINES 791 THROUGH 803 BECAUSE HORIZONTAL AND VERTICAL MISS DISTANCES HAVE ALREADY BEEN ACCOUNTED FOR BY LINES 714 THROUGH 731.

791- 803 CALCULATIONS APPLY ONLY IF K KILL HAS BEEN INFLICTED ON TARGET. SINCE MISS DISTANCES ALREADY PROCESSED BY LINES 714 THROUGH 731 ARE NOT TO BE COUNTED, CORRESPONDING COUNTERS IN NMINUS ARRAY AND/OR NPLUS ARRAY ARE REDUCED ACCORDINGLY.

805- 828 PROCESSING FOR HITTING ROUND CONTINUES WITH ACCOUNTING FOR PASSENGER PERSONNEL CASUALTIES, AS NECESSARY, AND DETERMINATION OF WHETHER ENGAGEMENT HAS BEEN COMPLETED.

805- 806 INITIAL SETTINGS.

807- 828 NONZERO VALUE OF PASSN INDICATES PASSENGER PERSONNEL CASUALTIES NEED TO BE CONSIDERED. EXPECTED CASUALTIES PER HIT HAVE ALREADY BEEN STORED IN PK(5) FOR TARGET ORIENTATION ANGLE OF 0, 30, 60, OR 90 DEGREES, OR IN PK(10) FOR ASSOCIATED REVERSE ANGLE. RATIO CASLT/PASSN INDICATES WHAT FRACTION OF PASSENGER PERSONNEL CARRIED IN TARGET VEHICLE WOULD BECOME CASUALTIES FROM EFFECTS OF ROUND BEING PROCESSED IF NO CASUALTY HAD BEEN CREDITED TO ANY PREVIOUS ROUND. DIFFERENCE PASSN-SUMCASE, WHICH EQUALS ORIGINAL NUMBER OF PASSENGER PERSONNEL PASSN IF TOTAL CASUALTIES SUMCASE INFLICTED BY PREVIOUS ROUNDS EQUAL ZERO, REPRESENTS HOW MANY PASSENGER PERSONNEL HAVE NOT ALREADY BECOME CASUALTIES. UPDATE SUMCASE TO ACCOUNT FOR ADDITIONAL CASUALTIES, REASONABLY ESTIMATED AS PRODUCT OF RATIO CASLT/PASSN AND DIFFERENCE PASSN-SUMCASE, THAT RESULT FROM ROUND OF CURRENT CONCERN. UPDATE Z ARRAY SO THAT Z(J,11), OR Z(J,12) FOR REVERSE ANGLE, REPRESENTS TOTAL NUMBER OF PASSENGER PERSONNEL CASUALTIES INFLICTED, IN ALL SAMPLE ENGAGEMENTS PROCESSED SO FAR, BY FIRST J ROUNDS. FIRST THREE CONDITIONAL STATEMENTS IN DO 5550 LOOP ENSURE CONSIDERATION OF PROPER K VALUES, BE THEY 1 THROUGH 4 OR 6 THROUGH 9. IF C(K) EVER EQUALS 0, ENGAGEMENT IS STILL INCOMPLETE UNLESS CURRENT PROCESSING INVOLVES LAST OF NRDS ROUNDS ALLOWED AS MAXIMUM. IF ALL FOUR C(K) VALUES OF CONCERN EQUAL 1, PROCEED TO NEXT ENGAGEMENT BUT ONLY AFTER UPDATING, AS NECESSARY, CUMULATIVE PERSONNEL CASUALTIES IN Z ARRAY FOR ROUNDS WHICH NEED NOT BE FIRED IN CURRENT ENGAGEMENT.

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                GO TO 5510
800       5515  NCOORD = COORD(I)/20.0 + 1.0
                IF ( NCOORD .GT. 50 ) NCOORD = 50
                NPLUS(NCOORD,I,N) = NPLUS(NCOORD,I,N) - 1
          5510  CONTINUE
          5505  CONTINUE
805             KCAS = 5
                IF ( NBETA .EQ. NANGLE ) KCAS = 10
                IF ( PASSN .LE. 0.0 ) GO TO 5545
                CASLT = PK(KCAS)
                SUMCASE = SUMCASE + (CASLT/PASSN)*(PASSN-SUMCASE)
810             IF ( NBETA .EQ. NANGLE ) GO TO 5535
                Z(J,11) = Z(J,11) + SUMCASE
                GO TO 5545
          5535  Z(J,12) = Z(J,12) + SUMCASE
          5545  DO 5550 K = 1,10
815             IF ( K .EQ. 5 .OR. K .EQ. 10 ) GO TO 5550
                IF ( K .GT. KCAS ) GO TO 5550
                IF ( KCAS .EQ. 10 .AND. K .LT. 5 ) GO TO 5550
                IF ( C(K) .EQ. 0.0 ) GO TO 5800
          5550  CONTINUE
820             IF ( J .EQ. NRDS ) GO TO 6000
                JNXT = J + 1
                DO 5560 K = JNXT,NRDS
                IF ( NBETA .EQ. NANGLE ) GO TO 5565
                Z(K,11) = Z(K,11) + SUMCASE
825             GO TO 5560
          5565  Z(K,12) = Z(K,12) + SUMCASE
          5560  CONTINUE
                GO TO 6000
          5600  CONTINUE
830             IF ( J .GT. 1 ) GO TO 5605
                IF ( INTPL .EQ. 1 ) GO TO 5605
                IF ( NDTRM3 .EQ. 0 ) GO TO 5605
                N = 3
                COORD(1) = X1 - XRE - XC
835             COORD(2) = Y1 - YRE - YC
                DO 5610 I = 1,2
                IF ( COORD(I) .GE. 0.0 ) GO TO 5615
                NCOORD = -COORD(I)/20.0 + 1.0
                IF ( NCOORD .GT. 50 ) NCOORD = 50
840             NMINUS(NCOORD,I,N) = NMINUS(NCOORD,I,N) + 1
                GO TO 5610
          5615  NCOORD = COORD(I)/20.0 + 1.0
                IF ( NCOORD .GT. 50 ) NCOORD = 50
                NPLUS(NCOORD,I,N) = NPLUS(NCOORD,I,N) + 1
845       5610  CONTINUE
          5605  CONTINUE
                IF ( NADJST .NE. 2 ) GO TO 5625
                IF ( Y1 .LT. YBASE ) GO TO 5635
                YC1 = YC1 - DROP
850             GO TO 5800
          5635  CONTINUE
                YC1 = YC1 + DROP
                GO TO 5800
          5625  CONTINUE
855             CALL NRAN(R1,R2)
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830– B84 CYCLE FOR EACH ROUND THAT IS FIRED, FLIES RELIABLY, AND MISSES TARGET.

B30– B32 PROGRAM LINES B33 THROUGH B45 INVOLVE SPECIAL CALCULATIONS ASSOCIATED WITH NDTRM3 EQUALLING 1. THESE CALCULATIONS CANNOT BE ATTEMPTED IF ROUND INDEX J INDICATES THAT SOME SUBSEQUENT ROUND RATHER THAN FIRST ROUND IS BEING PROCESSED OR IF RANGE INTERPOLATION OF TARGET VULNERABILITY DATA IS NEEDED.

833– B45 N EQUALLING 3 CORRESPONDS TO ALL FIRST ROUNDS THAT MISS TARGET. MISS DISTANCES FOR SUCH ROUNDS ARE USED FOR SETTING COUNTERS IN NMINUS AND NPLUS ARRAYS IN SAME MANNER THAT MISS DISTANCES FOR FIRST ROUNDS HITTING TARGET ARE PROCESSED BY PROGRAM LINES 714 THROUGH 731.

B47– B53 IGNORE STATEMENTS APPLICABLE ONLY FOR NADJST EQUALLING 2.

855 RANDOM NORMAL DEVIATES ARE OBTAINED FOR POSSIBLE LATER USE IN PROGRAM LINES B5B AND 859 OR LINES B75 AND B76.

856 PROGRAM LINES B57 THROUGH 860 APPLY FOR BASIC ADJUSTMENT PROCEDURE AND ARE SKIPPED IF NADJUST IS 1.

857– 860 IF NADJST EQUALS 0, RANDOM NUMBER IS COMPARED TO PROBABILITY PROBS OF ROUND BEING SENSED. IF ROUND IS NOT SENSED, BURST-ON-TARGET ADJUSTMENT IS NOT MADE AND PROCESSING CONTINUES AT PROGRAM STATEMENT 5700. OTHERWISE DETERMINE ADJX AND ADJY. THESE TWO QUANTITIES, RELATED TO BURST-ON-TARGET ADJUSTMENT, ARE EXPLAINED IN CONNECTION WITH PROGRAM LINES 882 THROUGH 884 WHERE PROCESSING CONTINUES.

B61– 881 ADJX AND ADJY ARE DETERMINED FOR NADJST EQUALLING 1. TWO QUANTITIES, RELATED TO BURST-ON-TARGET ADJUSTMENT, ARE EXPLAINED IN CONNECTION WITH PROGRAM LINES 882 THROUGH 884.

B61– B64 NHIGH EQUALS 0 IF MISSING ROUND IS SHORT OF TARGET, 1 OTHERWISE. HIGH AND SHORT ARE REAL FORMS. PRSCG IS SET TO APPLICABLE PROBABILITY OF SENSING FOR GUNNER AND/OR COMMANDER.

B65– B72 RANDOM NUMBER RANF(DUM) IS STORED IN RANDOM FOR REUSE IN PROGRAM LINE 878. COMPARE RANDOM TO PROBABILITY OF ROUND BEING SENSED BY GUNNER AND/OR COMMANDER. PROCESSING CONTINUES AT PROGRAM STATEMENT 5655 IF ROUND IS SENSED. OTHERWISE NUMBER NFAIL OF UNSENSED ROUNDS IS UPDATED. IF NFAIL THEN EQUALS 1, DROP AIMPOINT BY HALF TARGET HEIGHT BEFORE CONSIDERATION OF NEXT ROUND. TWO FAILURES TO SENSE CAUSE THIS OUTCOME TO BE RECORDED IN AFAIL ARRAY AND ENGAGEMENT TO BE ENDED.

873– B81 SET SGX AND SGY TO APPLICABLE HORIZONTAL AND VERTICAL SENSING ERROR STANDARD DEVIATIONS FOR GUNNER, DETERMINE CORRESPONDING PARTICULAR ERRORS ADJX AND ADJY, AND SET PRSG TO APPLICABLE PROBABILITY OF ROUND BEING SENSED BY GUNNER. COMPARE RANDOM TO GUNNER SENSING PROBABILITY TO ESTABLISH WHETHER GUNNER OR COMMANDER SHOULD BE CREDITED WITH SENSING. IF GUNNER SENSED ROUND, ADJX AND ADJY ARE ALREADY CORRECT. OTHERWISE ADJUSTMENTS ARE MADE TO ACCOUNT FOR ADDITIONAL ERRORS ASSOCIATED WITH SENSING OF ROUND BY COMMANDER WITH INFORMATION TRANSMITTAL TO GUNNER.

B82– B84 THESE STATEMENTS COMPLETE ACCOUNTING FOR BURST-ON-TARGET ADJUSTMENT BASED ON SENSING. UPDATED VALUES OF XC1 AND YC1 ARE COORDINATES OF POINT IN TARGET COORDINATE SYSTEM WHERE NEXT ROUND WOULD IMPACT IF THERE WERE NO RANDOM ERRORS. XC1 IS OBTAINED BY COMBINING 1) HORIZONTAL COORDINATE XC OF INTENDED AIMPOINT, 2) DIFFERENCE XC1-X1 WHICH INVOLVES XC1 AND X1 VALUES FROM EARLIER CALCULATIONS AND WHICH, AS CAN BE SEEN FROM PROGRAM LINE 668, CAUSES SPECIFIC HORIZONTAL RANDOM ERRORS THAT AFFECTED IMPACT POINT OF SENSED MISSING ROUND TO BE REMOVED, AND 3) ADJX VALUE RELATED TO BURST-ON-TARGET ADJUSTMENT. WHEN NADJST EQUALS 0, ADJX HAS BEEN OBTAINED BY APPLYING R1 TO

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      IF ( NADJST .EQ. 1 ) GO TO 5645
      IF ( RANF(DUM) .GT. PROBS ) GO TO 5700
      ADJX = R1 * SIGXS
      ADJY = R2 * SIGYS
860   GO TO 5650
5645  NHIGH = 1 - NSHORT
      HIGH = NHIGH
      SHORT = NSHORT
      PRSCG = HIGH*PGCH + SHORT*PGCS
865   RANDOM = RANF(DUM)
      IF ( RANDOM .LE. PRSCG ) GO TO 5655
      NFAIL = NFAIL + 1
      IF ( NFAIL .EQ. 2 ) GO TO 5665
      YC1 = YC1 - DROP
870   GO TO 5800
5665  AFAIL(J) = AFAIL(J) + 1.0
      GO TO 6000
5655  SGX = HIGH*SGHX + SHORT*SGSX
      SGY = HIGH*SGHY + SHORT*SGSY
875   ADJX = R1 * SGX
      ADJY = R2 * SGY
      PRSG = HIGH*PGH + SHORT*PGS
      IF ( RANDOM .LE. PRSG ) GO TO 5650
      CALL NRAN(R3,R4)
880   ADJX = ADJX + R3*CDRX
      ADJY = ADJY + R4*CDRY
5650  XC1 = XC1 - X1 + XC - ADJX
      YC1 = YC1 - Y1 + YC - ADJY
      FAC = 0.0
885   5700 IF ( PASSN .LE. 0.0 ) GO TO 5800
      IF ( NADJST .NE. 0 ) GO TO 5800
      IF ( NBETA .EQ. NANGLE ) GO TO 5735
      Z(J,11) = Z(J,11) + SUMCASE
      GO TO 5800
890   5735 Z(J,12) = Z(J,12) + SUMCASE
5800  IF ( J .LT. NRDS ) GO TO 5200
6000  CONTINUE
      IF ( ISAMP .LT. NEND1 ) GO TO 5100
      IF ( INTPL .EQ. 0 ) GO TO 6005
895   IF ( ISAMP .GT. NEND1 ) GO TO 6015
      ISPLIT = ISPLIT + 1
      GO TO 9010
6015  IF ( ISAMP .LT. NSAMP ) GO TO 5100
      ISPLIT = ISPLIT + 1
900   IF ( ISPLIT .EQ. 3 ) GO TO 9010
6005  CONTINUE
      IF (NADJST .EQ. 0 ) GO TO 7000
      IFAIL = AFAIL(1)
      WRITE ( 6,1020 )
905   WRITE ( 6,6020 ) 1,IFAIL
6020  FORMAT ( 10X,2I10 )
      SUM = 0.0
      DO 6030 I2 = 2,NRDS
      SUM = SUM + AFAIL(I2-1)
910   IFAIL = AFAIL(I2) + SUM
      WRITE ( 6,6020 ) I2,IFAIL
6030  CONTINUE
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HORIZONTAL SENSING ERROR STANDARD DEVIATION SIGXS. WHEN NADJST EQUALS 1, ADJX HAS BEEN DETERMINED IN SIMILAR FASHION WITH CONSIDERATION OF POSSIBLY DIFFERENT ERRORS FOR GUNNER AND COMMANDER. MINUS SIGN IS USED WITH ADJX BECAUSE, IF ROUND IS SENSED AS BEING OFF IN ONE DIRECTION (FOR EXAMPLE, RIGHT AND DOWN), FIRING WEAPON IS MOVED IN OPPOSITE DIRECTION (IN THIS EXAMPLE, LEFT AND UP). TERMS IN FORMULA FOR YC1 PARALLEL THOSE IN XC1 FORMULA. FAC NEEDS TO BE RESET SO THAT LAY ERRORS WILL NO LONGER BE TREATED EXPLICITLY SINCE THEY ARE INCLUDED IN SENSING ERRORS.

885- 890 WHEN PASSN HAS NONZERO VALUE AND ENGAGEMENT INVOLVES BASIC ADJUSTMENT METHOD, UPDATE Z ARRAY TO ACCOUNT FOR CUMULATIVE PASSENGER PERSONNEL CASUALTIES CAUSED BY ROUNDS FIRED BEFORE MISSING ROUND OF CURRENT CONCERN.

891 PROCEED WITH NEXT ROUND UNLESS MAXIMUM NUMBER OF ROUNDS ALLOWED HAVE ALREADY BEEN ACCOUNTED FOR.

893- 901 PROCEED WITH NEXT SAMPLE ENGAGEMENT UNLESS ALL ENGAGEMENTS NEEDED AT THIS STAGE OF CALCULATIONS HAVE BEEN COMPLETED.

893- 894 SKIP PROGRAM LINES 895 THROUGH 900 IF ISAMP EQUALS NEND1 AND RUN DOES NOT INVOLVE RANGE INTERPOLATION OF VULNERABILITY DATA.

895- 897 WHEN ISAMP EQUALS NEND1, RESET ISPLIT TO INDICATE FIRST PART OF ENGAGEMENT SIMULATIONS FOR IC VALUE OF INTEREST AND ASSOCIATED FORWARD OR REVERSE ANGLE HAS BEEN COMPLETED. AFTER BEING RESET, ISPLIT EQUALS 1 FOR FORWARD ANGLE OR 2 FOR REVERSE ANGLE. CONTINUE PROCESSING AT PROGRAM STATEMENT 9010. PROGRAM LINE 895 CAUSES NEXT TWO LINES TO BE SKIPPED WHEN ISAMP EXCEEDS NEND1.

898- 900 PROCEED WITH NEXT ENGAGEMENT UNLESS ALL NSAMP ENGAGEMENTS HAVE BEEN COMPLETED. RESET ISPLIT TO 3 FOR FORWARD ANGLE OR 4 FOR REVERSE ANGLE TO INDICATE SECOND PART OF ENGAGEMENT SIMULATIONS FOR IC AND RELATED FORWARD OR REVERSE ANGLE HAS BEEN DONE. CONTINUE AT PROGRAM STATEMENT 9010 IF CALCULATIONS FOR REVERSE ANGLE ARE STILL INCOMPLETE.

903- 912 IFAIL ARRAY CONTAINS CUMULATED VALUES CORRESPONDING TO AFAIL ARRAY. IFAIL(I2) IS NUMBER OF ENGAGEMENTS IN WHICH SECOND FAILURE TO SENSE THAT CAUSED END OF ENGAGEMENT OCCURRED ON ROUND LESS THAN OR EQUAL TO I2. WRITE IFAIL ARRAY QUANTITIES.

914 PROGRAM LINES 915 THROUGH 1132 INVOLVE SPECIAL CALCULATIONS ASSOCIATED WITH AT LEAST ONE OF NDTRM1, NDTRM2, NDTRM3, NDTRM4, AND NDTRM5 EQUALLING 1. THESE CALCULATIONS CANNOT BE ATTEMPTED IF RANGE INTERPOLATION OF TARGET VULNERABILITY DATA HAS BEEN INVOLVED.

915-1132 THESE STATEMENTS ESSENTIALLY CONSTITUTE COMPUTER ROUTINE (ALTHOUGH STATEMENTS HAVE NOT BEEN STRUCTURED AS SEPARATE ROUTINE IN THIS PROGRAM) FOR PROCESSING HORIZONTAL OR VERTICAL OFFSET DISTANCES BASED ON IMPACT POINTS OF HITTING OR MISSING ROUNDS IN TARGET PLANE. OBJECTIVE OF PROCESSING IS TO ESTIMATE MEAN AND OBTAIN THREE ESTIMATES OF STANDARD DEVIATION FOR NORMAL DISTRIBUTIONS TENTATIVELY ASSUMED TO FIT SUCH OFFSET DATA. AFTER COMPLETION OF COMPUTER RUN, ANALYST CAN STUDY THREE SETS OF PARAMETERS TO JUDGE HOW CLOSELY NORMAL DISTRIBUTION APPLIES AND TO MAKE BEST ESTIMATE FOR PARAMETERS OF INTEREST. PAPER EXPLAINING PROCESSING OF OFFSET DISTANCES WAS PRESENTED AT 1979 ARMY NUMERICAL ANALYSIS AND COMPUTERS CONFERENCE. THIS PAPER (WITH MINOR CHANGES) IS INCLUDED AS APPENDIX B OF THIS REPORT. N EQUALLING 1, 2, OR 3 IS RELATED TO HITTING OR MISSING FIRST ROUNDS AS ALREADY EXPLAINED. PROVISION HAS ALSO BEEN MADE FOR N VALUES OF 4 AND 5 TO BE AVAILABLE FOR POSSIBLE FUTURE USE. CALCULATIONS INVOLVING ANY PARTICULAR N VALUE ARE DONE ONLY IF CONTROL QUANTITY KDMSTC(N) IS NOT 0.

1134-1135 PROGRAM LINES 1136 THROUGH 1295 INVOLVE DETERMINISTIC CALCULATIONS OF HIT

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      7000 CONTINUE
           IF ( ISPLIT .EQ. 4 ) GO TO 7400
 915       N = 0
      7005 IF ( N .EQ. 5 ) GO TO 7400
           N = N + 1
           IF ( KDMSTC(N) .EQ. 0 ) GO TO 7005
           DO 7010 I = 1,2
 920       AVRG = 0.0
           TMINUS = 0.0
           TPLUS = 0.0
           KTIMES = 0
           DO 7020 J = 1,50
 925       TERM1 = NMINUS(J,I,N)
           TERM2 = NPLUS(J,I,N)
           TMINUS = TMINUS + TERM1
      7020 TPLUS = TPLUS + TERM2
           TOTAL(I) = TMINUS + TPLUS
 930       NTOTAL = TOTAL(I)
           T5000 = TOTAL(I) * 0.5
           N5000 = T5000
           IF ( T5000 .NE. TMINUS ) GO TO 7024
           DO 7022 K = 1,50
 935       NPOS(K) = NPLUS(K,I,N)
      7022 NNEG(K) = NMINUS(K,I,N)
           GO TO 7200
      7024 IF ( T5000 .LT. TMINUS ) GO TO 7025
           DIFF = T5000 - TMINUS
 940       DO 7030 J = 1,50
           PLUS = NPLUS(J,I,N)
           IF ( PLUS .LT. DIFF ) GO TO 7035
           IFRCTN = 1000.0 * DIFF / PLUS
           FRCTN = FLOAT(IFRCTN) / 1000.0
 945       AVRG = AVRG + FRCTN*20.0
           JEND = 100 - KTIMES
           LTIMES = 50 - KTIMES
           LEND = 1 + KTIMES
           DO 7040 K = 1,50
 950       NNEG(K) = 0
      7040 NPOS(K) = 0
           NCMLTN = 0
           NCMLTP = 0
           L = 0
 955   7050 IF ( L .EQ. 100 ) GO TO 7200
           L = L + 1
           LL = L
           IF ( L .LE. 50 ) LL = 51 - L
           M = L
 960       IF ( L .GT. 50 ) M = L - 50
           IF ( LL .LE. JEND ) GOTO 7055
           NPOS(M) = 0
           GO TO 7060
      7055 IF ( LL .LT. JEND ) GOTO 7065
 965       NTERM = (IFRCTN*NPLUS(50,I,N)+500) / 1000
           NPOS(M) = NPLUS(50,I,N) - NTERM
           NCMLTP = NCMLTP + NPOS(M)
           GO TO 7060
      7065 IF ( LL .LE. LTIMES ) GOTO 7075
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      970         IF ( LL .LE. 50 ) GOTO 7070
                  NTERM1 = (IFRCTN*NPLUS(L-LTIMES,I,N)+500) / 1000
                  NTERM2 = (IFRCTN*NPLUS(L-LTIMES+1,I,N)+500) / 1000
                  NPOS(M) = NPLUS(L-LTIMES,I,N) - NTERM1 + NTERM2
                  NCMLTP = NCMLTP + NPOS(M)
      975         GO TO 7060
                7070 NTERM1 = (IFRCTN*NPLUS(LEND-M,I,N)+500) / 1000
                  NTERM2 = (IFRCTN*NPLUS(LEND-M+1,I,N)+500) / 1000
                  NNEG(M) = NPLUS(LEND-M,I,N) - NTERM1 + NTERM2
                  NCMLTN = NCMLTN + NNEG(M)
      980         GO TO 7060
                7075 IF ( LL .LT. LTIMES ) GOTO 7085
                  NTERM1 = (IFRCTN*NMINUS(1,I,N)+500) / 1000
                  NTERM2 = (IFRCTN*NPLUS(1,I,N)+500) / 1000
                  NNEG(M) = NMINUS(1,I,N) - NTERM1 + NTERM2
      985         NCMLTN = NCMLTN + NNEG(M)
                  GO TO 7060
                7085 IF ( LL .EQ. 1 ) GO TO 7095
                  NTERM1 = (IFRCTN*NMINUS(LTIMES-LL+1,I,N)+500) / 1000
                  NTERM2 = (IFRCTN*NMINUS(LTIMES-LL,I,N)+500) / 1000
      990         NNEG(L-KTIMES+1) = NMINUS(LTIMES-LL+1,I,N) - NTERM1 + NTERM2
                  NCMLTN = NCMLTN + NNEG(L-KTIMES+1)
                  GO TO 7060
                7095 NNEG(50) = (IFRCTN*NMINUS(49-KTIMES,I,N)+500) / 1000
                  NXTRA = KTIMES + 1
      995         DO 7100 JXTRA = 1,NXTRA
                7100 NNEG(50) = NNEG(50) + NMINUS(49-KTIMES+JXTRA,I,N)
                  NTERM = (IFRCTN*NMINUS(50,I,N)+500) / 1000
                  NNEG(50) = NNEG(50) + NTERM
                  NCMLTN = NCMLTN + NNEG(50)
     1000         7060 IF ( NCMLTP .EQ. NTOTAL ) L = 100
                  IF ( L .GT. 50 ) GO TO 7050
                  IF ( NCMLTN .LT. N5000 ) GO TO 7050
                  NCMLTP = NCMLTN
                  L = 50
     1005         GO TO 7050
                7035 DIFF = DIFF - PLUS
                  KTIMES = KTIMES + 1
                  AVRG = AVRG + 20.0
                7030 CONTINUE
     1010         7025 DIFF = TMINUS - T5000
                  DO 7110 J = 1,50
                  AMINUS = NMINUS(J,I,N)
                  IF ( AMINUS .LT. DIFF ) GO TO 7115
                  IFRCTN = 1000.0 * DIFF / AMINUS
     1015         FRCTN = FLOAT(IFRCTN) / 1000.0
                  AVRG = AVRG - FRCTN*20.0
                  JEND = 100 - KTIMES
                  LTIMES = 50 - KTIMES
                  LEND = 1 + KTIMES
     1020         DO 7120 K = 1,50
                  NPOS(K) = 0
                7120 NNEG(K) = 0
                  NCMLTP = 0
                  NCMLTN = 0
     1025         L = 0
                7130 IF ( L .EQ. 100 ) GO TO 7200
```

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                L = L + 1
                LL = L
                IF ( L .LE. 50 ) LL = 51 - L
1030            M = L
                IF ( L .GT. 50 ) M = L - 50
                IF ( LL .LE. JEND ) GOTO 7135
                NNEG(M) = 0
                GO TO 7140
1035       7135 IF ( LL .LT. JEND ) GOTO 7145
                NTERM = (IFRCTN*NMINUS(50,I,N)+500) / 1000
                NNEG(M) = NMINUS(50,I,N) - NTERM
                NCMLTN = NCMLTN + NNEG(M)
                GO TO 7140
1040       7145 IF ( LL .LE. LTIMES ) GOTO 7155
                IF ( LL .LE. 50 ) GOTO 7150
                NTERM1 = (IFRCTN*NMINUS(L-LTIMES,I,N)+500) / 1000
                NTERM2 = (IFRCTN*NMINUS(L-LTIMES+1,I,N)+500) / 1000
                NNEG(M) = NMINUS(L-LTIMES,I,N) - NTERM1 + NTERM2
1045            NCMLTN = NCMLTN + NNEG(M)
                GO TO 7140
           7150 NTERM1 = (IFRCTN*NMINUS(LEND-M,I,N)+500) / 1000
                NTERM2 = (IFRCTN*NMINUS(LEND-M+1,I,N)+500) / 1000
                NPOS(M) = NMINUS(LEND-M,I,N) - NTERM1 + NTERM2
1050            NCMLTP = NCMLTP + NPOS(M)
                GO TO 7140
           7155 IF ( LL .LT. LTIMES ) GOTO 7165
                NTERM1 = (IFRCTN*NPLUS(1,I,N)+500) / 1000
                NTERM2 = (IFRCTN*NMINUS(1,I,N)+500) / 1000
1055            NPOS(M) = NPLUS(1,I,N) - NTERM1 + NTERM2
                NCMLTP = NCMLTP + NPOS(M)
                GO TO 7140
           7165 IF ( LL .EQ. 1 ) GO TO 7175
                NTERM1 = (IFRCTN*NPLUS(LTIMES-LL+1,I,N)+500) / 1000
1060            NTERM2 = (IFRCTN*NPLUS(LTIMES-LL,I,N)+500) / 1000
                NPOS(L-KTIMES+1) = NPLUS(LTIMES-LL+1,I,N) - NTERM1 + NTERM2
                NCMLTP = NCMLTP + NPOS(L-KTIMES+1)
                GO TO 7140
           7175 NPOS(50) = (IFRCTN*NPLUS(49-KTIMES,I,N)+500) / 1000
1065            NXTRA = KTIMES + 1
                DO 7180 JXTRA = 1,NXTRA
           7180 NPOS(50) = NPOS(50) + NPLUS(49-KTIMES+JXTRA,I,N)
                NTERM = (IFRCTN*NPLUS(50,I,N)+500) / 1000
                NPOS(50) = NPOS(50) + NTERM
1070            NCMLTP = NCMLTP + NPOS(50)
           7140 IF ( NCMLTN .EQ. NTOTAL ) L = 100
                IF ( L .GT. 50 ) GO TO 7130
                IF ( NCMLTP .LT. N5000 ) GO TO 7130
                NCMLTN = NCMLTP
1075            L = 50
                GO TO 7130
           7115 DIFF = DIFF - AMINUS
                KTIMES = KTIMES + 1
                AVRG = AVRG - 20.0
1080       7110 CONTINUE
           7200 CONTINUE
                DO 7310 K = 1,50
                IF ( K .GT. 1 ) GO TO 7315
```

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                      NSUM1 = NPOS(K)
1085                  NSUM2 = NNEG(K)
                      GO TO 7320
                 7315 NSUM1 = NSUM1 + NPOS(K)
                      NSUM2 = NSUM2 + NNEG(K)
                 7320 NCMPOS(K) = NSUM1
1090                  NCMNEG(K) = NSUM2
                      NRFLCT(K) = NSUM1 + NSUM2
                 7310 CONTINUE
                      DO 7330 J = 1,50
                      SIGMAX = J * 20
1095                  IF ( J .GT. 1 ) GO TO 7335
                      SMFRQ1 = 0.0
                      SMFRQ2 = NRFLCT(1) * 10000 / NTOTAL
                      K5 = 5
                      K10 = 10
1100                  GO TO 7350
                 7335 SMFRQ1 = SMFRQ2
                      IF ( J .EQ. 50 ) GO TO 7345
                      SMFRQ2 = NRFLCT(J) * 10000 / NTOTAL
                      GO TO 7350
1105             7345 SMFRQ2 = 10000.0
                 7350 FRQNCY = SMFRQ2 - SMFRQ1
                      IF ( K5 .NE. 5 ) GO TO 7355
                      IF ( SMFRQ2 .LT. 3829.2 ) GOTO 7330
                      D05 = (SMFRQ2-3829.2) / FRQNCY
1110                  SIG05 = (SIGMAX-D05*20.0) / 0.5
                      K5 = 0
                 7355 IF ( K10 .NE. 10 ) GO TO 7365
                      IF ( SMFRQ2 .LT. 6826.8 ) GOTO 7330
                      D10 = (SMFRQ2-6826.8) / FRQNCY
1115                  SIG10 = SIGMAX - D10*20.0
                      K10 = 0
                 7365 IF ( SMFRQ2 .LT. 8663.8 ) GOTO 7330
                      D15 = (SMFRQ2-8663.8) / FRQNCY
                      SIG15 = (SIGMAX-D15*20.0) / 1.5
1120                  GO TO 7370
                 7330 CONTINUE
                 7370 WRITE ( 6,1020 )
                      WRITE ( 6,7380) N,I,SIG05,SIG10,SIG15
                 7380 FORMAT ( 10X,26H N,I,SIG05,SIG10,SIG15    ,2I10,3F10.4 )
1125                  BIASXY(I,N) = AVRG
                      IF ( I .EQ. 1 ) SSQRRE = SIGXL**2 + SIGXR**2
                      IF ( I .EQ. 2 ) SSQRRE = SIGYL**2 + SIGYR**2
                      SIGMXY(1,I,N) = SQRT(SIG05**2+SSQRRE)
                      SIGMXY(2,I,N) = SQRT(SIG10**2+SSQRRE)
1130                  SIGMXY(3,I,N) = SQRT(SIG15**2+SSQRRE)
                 7010 CONTINUE
                      GO TO 7005
                 7400 CONTINUE
                      IF ( NSMDTR .EQ. 0 .AND. NHTKLL .EQ. 0 ) GOTO 8000
1135                  IF ( ISPLIT .EQ. 4 .AND. NHTKLL .EQ. 0 ) GO TO 8000
                      NCLLS1 = 99999
                      NCLLS2 = 99999
                      IF ( NSMDTR .EQ. 0 ) GO TO 7405
                      IF ( ISPLIT .EQ. 4 ) GO TO 7405
1140                  NCLLS1 = 0
```

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                      DO 7410 N = 1,5
                      BX(N) = BIASXY(1,N)
                      BY(N) = BIASXY(2,N)
                      DO 7410 K = 1,3
1145                  PH(K,N) = 0.0
                      SIGX(K,N) = SIGMXY(K,1,N)
                      SIGY(K,N) = SIGMXY(K,2,N)
                      DO 7410 L = 1,4
                      PKILL(L,K,N) = 0.0
1150            7410  CONTINUE
                7405  IF ( NHTKLL .EQ. 0 ) GO TO 7415
                      NCLLS2 = 0
                      DO 7420 N = 1,5
                      PPH(N) = 0.0
1155                  IF ( N .EQ. 5 ) PPH(N) = 1.0
                      DO 7420 L = 1,4
                      PKSHOT(L,N) = 0.0
                      PPKHIT(L,N) = 0.0
                7420  CONTINUE
1160            7415  DO 7430 J = 1,NY
                      IF ( AY(J)+H .LE. YBASE ) GO TO 7430
                      Y2 = AY(J) + H - YC
                      Y1 = AY(J) - H - YC
                      IF ( Y1 .LT. YBASE-YC ) Y1 = YBASE - YC
1165                  DO 7440 I = 1,NX
                      K22 = IK(J,I)
                      IF ( K22 .LE. 0 ) GO TO 7440
                      X2 = AX(I) + H - XC
                      X1 = AX(I) - H - XC
1170                  IF ( NPRHIT .EQ. 1 ) GO TO 7445
                      N = -49
                      DO 7450 L = 1,4
                      IF ( NBETA .EQ. NANGLE ) GO TO 7452
                      IST = SHIFT(MPK(K22,IA),N) .AND. MASK11
1175                  ST = IST
                      PK(L) = 0.001 * ST
                      GO TO 7450
                7452  IST1 = SHIFT(MPK(K22,IB),N) .AND. MASK11
                      ST1 = IST1
1180                  PK(L+5) = 0.001 * ST1
                7450  N = N + 11
                7445  IF ( NSMDTR .EQ. 0 ) GO TO 7475
                      IF ( ISPLIT .EQ. 4 ) GO TO 7475
                      N = 0
1185            7455  IF ( N .EQ. 5 ) GO TO 7475
                      N = N + 1
                      IF ( KDMSTC(N) .EQ. 0 ) GO TO 7455
                      DO 7460 K = 1,3
                      QOFZ1 = CNORM((X2-BX(N))/SIGX(K,N))
1190                  QOFZ2 = CNORM((X1-BX(N))/SIGX(K,N))
                      QOFZ3 = CNORM((Y2-BY(N))/SIGY(K,N))
                      QOFZ4 = CNORM((Y1-BY(N))/SIGY(K,N))
                      POFXY = (QOFZ1-QOFZ2) * (QOFZ3-QOFZ4)
                      PH(K,N) = PH(K,N) + POFXY
1195                  IF ( NPRHIT .EQ. 1 ) GO TO 7460
                      DO 7470 L = 1,4
                      PKCELL = PK(L)
```

PROBABILITIES AND KILL PROBABILITIES. LINES NEED TO BE SKIPPED WHEN NSMDTR AND NHTKLL CONTROLS ARE BOTH 0. CONDITION INVOLVING ISPLIT EQUALLING 4 CAUSES LINES TO BE SKIPPED ONLY FOR RANGES REQUIRING INTERPOLATION OF VULNERABILITY DATA IF NSMDTR IS NOT 0.

1136-1137 INITIAL SETTINGS.

1138-1139 PROGRAM LINES 1140 THROUGH 1150 CAN BE INVOLVED ONLY IF NSMDTR EXCEEDS 0 AND RANGE OF CONCERN DOES NOT REQUIRE INTERPOLATION OF VULNERABILITY DATA.

1140 NEW INITIAL SETTING OVERRIDING 99999.

1141-1150 INITIAL SETTINGS.

1151 PROGRAM LINES 1152 THROUGH 1159 CAN BE INVOLVED ONLY IF NHTKLL EXCEEDS 0.

1152 NEW INITIAL SETTING OVERRIDING 99999.

1153-1159 INITIAL SETTINGS.

1160-1227 CONSIDER IN TURN EACH HORIZONTAL STRIP OF CELLS IN SMALLEST RECTANGLE ENCLOSING TARGET.

1161-1164 DETERMINE Y COORDINATES Y1 AND Y2 CORRESPONDING TO LOWER AND UPPER EDGES RESPECTIVELY OF PARTICULAR STRIP. AY(J) REPRESENTS Y COORDINATE OF HORIZONTAL CENTERLINE OF STRIP. IGNORE STRIP IF ITS CENTERLINE IS BELOW BASE OF TARGET. IF NECESSARY, RESET Y1 TO MAKE IT CORRESPOND TO TARGET BASE.

1165-1226 CONSIDER IN TURN EACH CELL IN PARTICULAR HORIZONTAL STRIP.

1166-1167 K22 IS USED FOR TEMPORARY STORAGE OF IK(J,I) VALUE ASSOCIATED WITH PARTICULAR CELL. IGNORE CELL WHEN K22 EQUALLING 0 INDICATES CELL IS NOT PART OF TARGET.

1168-1169 DETERMINE X COORDINATES X1 AND X2 CORRESPONDING RESPECTIVELY TO LEFT AND RIGHT EDGES OF TARGET CELL.

1170 SKIP PROGRAM LINES 1171 THROUGH 1181 IF ONLY HIT PROBABILITIES ARE INVOLVED.

1171-1181 UNPACK MPK ARRAY QUANTITY THAT CORRESPONDS TO TARGET CELL HIT AND ASSOCIATED TARGET ORIENTATION TO RETRIEVE PROBABILITIES OF M KILL, F KILL, M OR F KILL, AND K KILL PER HIT. STORE THESE IN PK ARRAY. THESE PROGRAM LINES ARE ESSENTIALLY LIKE LINES 753 THROUGH 763. EXCEPT FOR EXPECTED CASUALTIES NOT BEING OF CONCERN HERE, EXPLANATIONS FOR LINES 753 THROUGH 772 APPLY.

1182-1183 SKIP PROGRAM LINES 1184 THROUGH 1203 IF NSMDTR IS 0 OR IF RANGE OF CONCERN INVOLVES INTERPOLATION OF VULNERABILITY DATA.

1184-1187 PROCESSING INDICATED BY PROGRAM LINES 1188 THROUGH 1203 IS DONE OR SKIPPED FOR N EQUALLING 1, 2, 3, 4, OR 5 ACCORDING TO WHETHER KDMSTC(N) EXCEEDS OR EQUALS 0.

1188-1201 K CORRESPONDS TO THREE ALTERNATIVE SETS OF STANDARD DEVIATIONS ESTIMATED FOR HORIZONTAL AND VERTICAL OFFSET DISTANCE DATA FROM SIMULATED ENGAGEMENTS.

1189-1194 QOFZ1 IS PROBABILITY THAT PARTICULAR PAIR OF BIAS AND STANDARD DEVIATION VALUES RESULTS IN X COORDINATE OF PROJECTILE IMPACT POINT NOT EXCEEDING X COORDINATE OF RIGHT EDGE OF CELL BEING CONSIDERED. QOFZ2 IS PROBABILITY X COORDINATE OF IMPACT POINT DOES NOT EXCEED THAT OF LEFT EDGE OF CELL. DIFFERENCE QOFZ1-QOFZ2 EQUALS PROBABILITY THAT IMPACT POINT LIES ON VERTICAL LINE THROUGH SOME CELL POINT. SIMILARLY, DIFFERENCE QOFZ3-QOFZ4 EQUALS PROBABILITY THAT IMPACT POINT LIES ON HORIZONTAL LINE THROUGH SOME CELL

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                      IF ( NBETA .EQ. NANGLE ) PKCELL = PK(L+5)
                      PKILL(L,K,N) = PKILL(L,K,N) + POFXY*PKCELL
1200          7470    CONTINUE
              7460    CONTINUE
                      NCLLS1 = NCLLS1 + 1
                      GO TO 7455
              7475    IF ( NHTKLL .EQ. 0 ) GO TO 7440
1205                  DO 7480 N = 1,5
                      IF ( N .EQ. 5 ) GO TO 7485
                      IF ( SSIGX(N) .EQ. 0.0 .OR. SSIGY(N) .EQ. 0.0 ) GO TO 7480
                      QQOFZ1 = CNORM((X2-BBX(N))/SSIGX(N))
                      QQOFZ2 = CNORM((X1-BBX(N))/SSIGX(N))
1210                  QQOFZ3 = CNORM((Y2-BBY(N))/SSIGY(N))
                      QQOFZ4 = CNORM((Y1-BBY(N))/SSIGY(N))
                      PPOFXY = (QQOFZ1-QQOFZ2) * (QQOFZ3-QQOFZ4)
                      PPH(N) = PPH(N) + PPOFXY
                      GO TO 7490
1215          7485    IF ( NRDTYP .EQ. 0 .AND. NRANGE .GT. 1 ) GO TO 7480
                      PPOFXY = 1.0
                      PPH(5) = PPH(5) + PPOFXY
              7490    NCLLS2 = NCLLS2 + 1
                      IF ( NPRHIT .EQ. 1 ) GO TO 7480
1220                  DO 7510 L = 1,4
                      PPCELL = PK(L)
                      IF ( NBETA .EQ. NANGLE ) PPCELL = PK(L+5)
                      PKSHOT(L,N) = PKSHOT(L,N) + PPOFXY*PPCELL
              7510    CONTINUE
1225          7480    CONTINUE
              7440    CONTINUE
              7430    CONTINUE
                      IF ( NHTKLL .EQ. 0 ) GO TO 7600
                      IF ( NPRHIT .EQ. 1 ) GO TO 7600
1230                  DO 7530 L = 1,4
                      DO 7540 N = 1,5
                      IF ( PPH(N) .GT. 0.000001 ) PPKHIT(L,N) = PKSHOT(L,N) / PPH(N)
              7540    CONTINUE
              7530    CONTINUE
1235          7600    CONTINUE
                      IF ( NSMDTR .EQ. 0 ) GOTO 7700
                      IF ( ISPLIT .EQ. 4 ) GO TO 7700
                      WRITE ( 6,1020 )
                      WRITE ( 6,7610 ) ( BX(I),I=1,5 )
1240          7610    FORMAT ( 10X,11H BX(5)      ,10X,5F10.4 )
                      WRITE ( 6,7620 ) ( BY(I),I=1,5 )
              7620    FORMAT ( 10X,11H BY(5)      ,10X,5F10.4 )
                      DO 7630 I = 1,3
                      WRITE ( 6,1020 )
1245                  WRITE ( 6,7640 ) ( SIGX(I,J),J=1,5 )
              7640    FORMAT ( 10X,11H SIGX(3,5) ,10X,5F10.4 )
                      WRITE ( 6,7650 ) ( SIGY(I,J),J=1,5 )
              7650    FORMAT ( 10X,11H SIGY(3,5) ,10X,5F10.4 )
                      WRITE ( 6,7660 ) ( PH(I,J),J=1,5 )
1250          7660    FORMAT ( 10X,21H PH(3,5)              ,5F10.4 )
              7630    CONTINUE
                      IF ( NPRHIT .EQ. 1 ) GOTO 7700
                      DO 7670 J = 1,3
                      WRITE ( 6,1020 )
```

POINT. PRODUCT POFXY OF TWO DIFFERENCES IS PROBABILITY OF HITTING CELL. EACH PH(K,N) VALUE IS CUMULATIVE HIT PROBABILITY FOR ALL CELLS ALREADY PROCESSED AND EVENTUALLY APPLIES TO ENTIRE TARGET.

1195 SKIP PROGRAM LINES 1196 THROUGH 1200 IF ONLY HIT PROBABILITIES ARE INVOLVED.

1196-1200 L CORRESPONDS TO FOUR KILL CRITERIA CONSIDERED IN TURN. PKCELL IS USED FOR TEMPORARY STORAGE OF PK(L) OR PK(L+5). THESE TWO VALUES APPLY TO FORWARD OR REVERSE ANGLE RESPECTIVELY. PRODUCT OF POFXY AND PKCELL IS PROBABILITY OF HITTING PARTICULAR CELL AND THEREBY KILLING TARGET. EACH PKILL(L,K,N) VALUE IS CUMULATIVE PROBALITY ACCOUNTING FOR ALL CELLS ALREADY PROCESSED AND EVENTUALLY EQUALS PROBABILITY OF HIT AND KILL FOR ENTIRE TARGET.

1202 NCLLS1 IS UPDATED AND EVENTUALLY EQUALS PRODUCT OF 1) TOTAL NUMBER OF TARGET CELLS AND 2) NUMBER OF NONZERO QUANTITIES IN SET KDMSTC(1), KDMSTC(2), KDMSTC(3), AND KDMSTC(4).

1203 PROCESSING HAS BEEN COMPLETED FOR PARTICULAR VALUE OF N AND MAY NEED TO BE REPEATED FOR SOME OTHER VALUE.

1204 PROGRAM LINES 1205 THROUGH 1225 CAN BE INVOLVED ONLY IF NHTKLL EXCEEDS 0.

1205-1225 N EQUALS 1 FOR FIRST ROUNDS, 2 FOR ROUNDS IMMEDIATELY FOLLOWING ROUND THAT HITS TARGET, 3 FOR ROUNDS IMMEDIATELY FOLLOWING SENSED MISS, 4 FOR ROUNDS IMMEDIATELY AFTER MISS THAT IS NOT SENSED, AND 5 FOR HITTING ROUNDS WHOSE IMPACT POINTS ARE CONSIDERED SPREAD UNIFORMLY AT RANDOM OVER VERTICAL TARGET AREA. CALCULATE HIT PROBABILITIES AND PROBABILITIES OF HITTING AND KILLING TARGET FOR N EQUALLING 1 THROUGH 4 AND KILL PROBABILITY OF RANDOM HIT FOR N EQUALLING 5.

1206-1207 CALCULATIONS CORRESPONDING TO PROGRAM LINES 1208 THROUGH 1214 ARE NOT APPLICABLE FOR N EQUALLING 5. FOR N EQUAL TO 1 THROUGH 4, PROCESSING INDICATED BY LINES 1208 THROUGH 1224 IS DONE WHEN NONZERO STANDARD DEVIATION INPUTS HAVE BEEN PREVIOUSLY ESTABLISHED OR IS OTHERWISE SKIPPED.

1208-1214 SIMILAR TO PROGRAM LINES 1189 THROUGH 1194. EACH PPH(N) VALUE IS CUMULATIVE HIT PROBABILITY FOR ALL CELLS ALREADY PROCESSED AND EVENTUALLY APPLIES TO ENTIRE TARGET. CONTINUE AT PROGRAM STATEMENT 2490.

1215 FOR NRDTYP EQUALLING 0, SKIP PROGRAM LINES 1216 THROUGH 1224 WHEN ASSOCIATED CALCULATIONS HAVE ALREADY BEEN DONE FOR FIRST RANGE. PROCESSING INVOLVED IS REPEATED FOR ALL OTHER RANGES WHEN TARGET VULNERABILITY DATA CAN VARY WITH RANGE.

1216-1217 FOR N EQUALLING 5, PROBABILITY OF HITTING EACH CELL IS NOT INVOLVED IN SAME WAY AS FOR OTHER N VALUES AND IS SET TO 1. THIS SPECIAL SETTING CAUSES PPH(5) TO BECOME CELL COUNTER.

1218 NCLLS2 IS UPDATED AND EVENTUALLY EQUALS PRODUCT OF 1) TOTAL NUMBER OF TARGET CELLS AND 2) NUMBER OF SETS OF NONZERO HORIZONTAL AND VERTICAL STANDARD DEVIATIONS USED FOR HIT PROBABILITY CALCULATIONS PLUS 1 IF SETTING OF PPOFXY TO 1.0 AND PROGRAM LINES 1220 THROUGH 1224 ARE NOT SKIPPED FOR N EQUAL TO 5.

1219 SKIP PROGRAM LINES 1220 THROUGH 1224 IF ONLY HIT PROBABILITIES ARE INVOLVED.

1220-1224 SIMILAR TO PROGRAM LINES 1196 THROUGH 1200. FOR N EQUALLING 1 THROUGH 4, EACH PKSHOT(L,N) VALUE IS CUMULATIVE PROBABILITY ACCOUNTING FOR ALL CELLS ALREADY PROCESSED AND EVENTUALLY EQUALS PROBABILITY OF HIT AND KILL FOR ENTIRE TARGET. PKSHOT(L,5) VALUES ARE SIMILAR BUT DO NOT REPRESENT PROBABILITIES.

1228 PROGRAM LINES 1230 THROUGH 1234 CAN BE INVOLVED ONLY IF NHTKLL EXCEEDS 0.

1229 SKIP PROGRAM LINES 1230 THROUGH 1234 IF ONLY HIT PROBABILITIES ARE INVOLVED.

1230-1234 DIVIDE PKSHOT(L,N) VALUES BY PPH(N) TO OBTAIN KILL PROBABILITIES PER HIT ON TARGET. FOR N EQUALLING 5, DIVISOR IS TOTAL NUMBER OF TARGET CELLS BECAUSE UNITY CHANCE OF HIT HAS BEEN PREVIOUSLY USED FOR EACH CELL.

1236-1237 PROGRAM LINES 1238 THROUGH 1258 CAN BE INVOLVED ONLY IF NSMDTR EXCEEDS 0 AND RANGE OF CONCERN DOES NOT REQUIRE INTERPOLATION OF VULNERABILITY DATA.

1238-1258 WRITE OUTPUT.

1260 PROGRAN LINES 1261 THROUGH 1292 CAN BE INVOLVED ONLY IF NHTKLL EXCEEDS 0.

1261-1292 WRITE OUTPUT.

1261-1263 SPECIAL TITLING INVOLVING IC AND MSET APPLIES ONLY FOR MOVING TARGET OR MOVING FIRING WEAPON RUN.

1275-1278 FOR MOVING TARGET OR MOVING FIRING WEAPON RUN, WRITE FIRST ROUND HIT PROBABILITY ONLY AFTER ADJUSTING TO ACCOUNT FOR RELIABILITY FACTOR RELT.

1280 SKIP PROGRAM LINES 1281 THROUGH 1292 IF ONLY HIT PROBABILITIES ARE INVOLVED.

1285-1288 FOR MOVING TARGET OR MOVING FIRING WEAPON RUN, WRITE KILL PROBABILITIES PER SHOT ONLY AFTER ADJUSTING TO ACCOUNT FOR RELIABILITY FACTORS RELT AND RELF.

1294-1295 WRITE NCLLS1 AND NCLLS2 FOR POSSIBLE USE IN CHECKING OUTPUT. EITHER QUANTITY STILL EQUALLING 99999 INDICATES ASSOCIATED CALCULATIONS WERE SKIPPED.

1297-1358 IF SIMULATED ENGAGEMENTS ARE INVOLVED IN RUN AND HAVE BEEN COMPLETED FOR BOTH TARGET ORIENTATION ANGLES OF CONCERN, PROCESS DATA IN Z AND AKIL ARRAYS AND PRINT OUTPUT.

1299-1315 CALCULATE AVERAGE VALUES PER SAMPLE ENGAGEMENT FOR EACH QUANTITY IN Z ARRAY. AVERAGE Z(I2,I) VALUES PER ENGAGEMENT FOR I EQUALLING 1 THROUGH 10 CAN BE INTERPRETED AS CORRESPONDING PROBABILITIES OF HITTING OR KILLING TARGET. PERSONNEL CASUALTIES ASSOCIATED WITH I EQUALLING 11 AND 12 REPRESENT AVERAGE EXPECTED CASUALTIES APPLICABLE TO TARGET VEHICLE PASSENGERS.

1317-1344 IF RUN INVOLVES SUBSEQUENT ROUNDS AS WELL AS FIRST ROUNDS AND BASIC FIRE ADJUSTMENT PROCEDURE FOR MISSING ROUNDS, CALCULATE AND PRINT AVERAGE NUMBERS OF ROUNDS NEEDED TO HIT TARGET AND TO ACHIEVE TARGET KILL ACCORDING TO VARIOUS CRITERIA CONSIDERED.

1322-1344 ACHIEVEMENT OF FIRST HIT AND KILLING OF TARGET ACCORDING TO VARIOUS CRITERIA ARE CONSIDERED FOR RELATED FORWARD AND REVERSE ORIENTATION ANGLES.

1323-1325 CONSIDER ONLY FIRST HIT ON TARGET WHEN NPRHIT EQUALS 1.

1327-1328 INITIAL SETTINGS.

1329-1340 AVERAGE (OR EXPECTED) NUMBER OF ROUNDS NEEDED FOR TARGET HIT OR TARGET KILL CAN BE OBTAINED BY ADDING ALL PRODUCTS OF 1) SPECIFIC NUMBER OF ROUNDS AND 2) CORRESPONDING FRACTION OF ALL ENGAGEMENTS FOR WHICH EXACTLY THAT NUMBER OF ROUNDS ARE REQUIRED TO HIT OR KILL TARGET. ONLY FIRST NRDS ROUNDS ARE PROCESSED EXPLICITLY IN THIS FASHION. APPROXIMATE EXTRAPOLATION FORMULA IS APPLIED AS NECESSARY TO ACCOUNT FOR ALL OTHER ROUNDS.

1329-1332 FOR I EQUAL TO 2, SMIK = SMIK + 2(Z(2,K)-Z(1,K)). TERM SMIK APPEARING TO RIGHT OF EQUAL SIGN IN THIS EQUATION IS EQUIVALENT TO 1(Z(1,K)). SINCE Z(2,K) IS

```
1255                DO 7670 I = 1,4
                    WRITE ( 6,7680 ) ( PKILL(I,J,K),K=1,5 )
                7680 FORMAT ( 10X,21H PKILL(4,3,5)          ,5F10.4 )
                7670 CONTINUE
                7700 CONTINUE
1260                IF ( NHTKLL .EQ. 0 ) GO TO 7800
                    IF ( ISTMOV .NE. 1 ) GO TO 7705
                    WRITE ( 6,7702 ) IC,MSET
                7702 FORMAT ( / /, 20X,6H IC = ,I3,10X,8H MSET = ,I3 )
                7705 WRITE ( 6,1020 )
1265                WRITE ( 6,7710 ) (BBX(I),I=1,4 )
                7710 FORMAT ( 10X,11H BBX(4)     ,10X,4F10.4 )
                    WRITE ( 6,7720 ) (BBY(I),I=1,4 )
                7720 FORMAT ( 10X,11H BBY(4)     ,10X,4F10.4 )
                    WRITE ( 6,7730 ) (SSIGX(I),I=1,4 )
1270            7730 FORMAT ( 10X,11H SSIGX(4)   ,10X,4F10.4 )
                    WRITE ( 6,7740 ) (SSIGY(I),I=1,4 )
                7740 FORMAT ( 10X,11H SSIGY(4)   ,10X,4F10.4 )
                    WRITE ( 6,7750 ) (PPH(I),I=1,5 )
                7750 FORMAT ( 10X,21H PPH(5)                ,5F10.4 )
1275                IF ( ISTMOV .NE. 1 ) GO TO 7755
                    PPH(1) = PPH(1) * RELT
                    WRITE ( 6,7753 ) (PPH(I),I=1,5 )
                7753 FORMAT ( 10X,21H PPH(5)                ,20X,5F10.4 )
                7755 CONTINUE
1280                IF ( NPRHIT .EQ. 1 ) GO TO 7800
                    DO 7760 I = 1,4
                    PKSHOT(I,5) = 0.0
                    WRITE ( 6,7770 ) (PKSHOT(I,J),J=1,5 )
                7770 FORMAT ( 10X,21H PKSHOT(4,5)           ,5F10.4 )
1285                IF ( ISTMOV .NE. 1 ) GO TO 7775
                    PKSHOT(I,1) = PKSHOT(I,1) * RELT * RELF
                    WRITE ( 6,7773 ) (PKSHOT(I,J),J=1,5 )
                7773 FORMAT ( 10X,21H PKSHOT(4,5)           ,20X,5F10.4 )
                7775 CONTINUE
1290                WRITE ( 6,7780 ) (PPKHIT(I,J),J=1,5 )
                7780 FORMAT ( 10X,21H PPKHIT(4,5)           ,5F10.4 )
                7760 CONTINUE
                7800 WRITE ( 6,1020 )
                    WRITE ( 6,7810 ) NCLLS1,NCLLS2
1295            7810 FORMAT ( 10X,18H NCLLS1, NCLLS2 = ,2I10 )
                8000 CONTINUE
                    IF ( NHTKLL .EQ. 9 ) GO TO 9000
                    IF ( NBETA .LT. NANGLE ) GO TO 9000
                    WRITE ( 6,8110 )
1300            8110 FORMAT ( / /, 11X,28H NRDS      PROB. (EXP. CAS.), / )
                    DO 8120 I = 1,12
                    IF ( I .GT. 10 .AND. PASSN .EQ. 0.0 ) GO TO 8125
                    DO 8120 I2 = 1,NRDS
                8120 Z(I2,I) = Z(I2,I) / SAMP
1305            8125 CONTINUE
                    DO 8130 N = 1,3
                    IF ( N .EQ. 3 .AND. PASSN .EQ. 0.0 ) GO TO 8200
                    WRITE ( 6,1020 )
                    IL = 5*N - 4
1310                IR = IL + 4
                    IF ( N .EQ. 3 ) IR = 12
```

```
                      DO 8130 I2 = 1,NRDS
                      WRITE ( 6,8140 ) I2,(Z(I2,I),I=IL,IR)
                 8140 FORMAT ( 11X,I4,9F13.7 )
1315             8130 CONTINUE
                 8200 CONTINUE
                      IF ( NRD1 .EQ. 1 ) GO TO 9000
                      IF ( NADJST .GT. 0 ) GO TO 8400
                      WRITE ( 6,8310 )
1320             8310 FORMAT ( / /, 31X,17H AVG. NO. OF RDS., / )
                      WRITE ( 6,1020 )
                      DO 8320 K = 1,10
                      IF ( NPRHIT .EQ. 0 ) GO TO 8325
                      IF ( K .EQ. 5 .OR. K .EQ. 10 ) GO TO 8325
1325                  GO TO 8320
                 8325 CONTINUE
                      SMIK = Z(1,K)
                      AUL = 2.0
                      DO 8330 I = 2,NRDS
1330                  SMIK = SMIK + AUL*(Z(I,K)-Z(I-1,K))
                 8330 AUL = AUL + 1.0
                      IF ( Z(NRDS,K) .LE. 0.9999 ) GO TO 8335
                      AV = SMIK
                      GO TO 8340
1335             8335 AR = 5.0 - (Z(NRDS-5,K)+Z(NRDS-4,K)+Z(NRDS-3,K)+Z(NRDS-2,K)
                     A           +Z(NRDS-1,K))
                      XX = Z(NRDS,K) - Z(NRDS-5,K)
                      IF ( XX .LE. 0.0 ) GO TO 8335
                      AZ = AR / XX
1340                  AV = SMIK + (AZ+RDS)*(1.0-Z(NRDS,K))
                 8340 IF ( AV .GT. 999.0 ) AV = 999.0
                      WRITE ( 6,8350 ) K,AV
                 8350 FORMAT ( 20X,I5,10X,F7.2 )
                 8320 CONTINUE
1345             8400 CONTINUE
                      WRITE ( 6,8402 )
                 8402 FORMAT ( / /, 22X,24H PROBABILITY VERSUS TIME, / )
                      DO 8410 J = 1,10
                      IF ( NPRHIT .EQ. 0 ) GO TO 8415
1350                  IF ( J .EQ. 5 .OR. J .EQ. 10 ) GO TO 8415
                      GO TO 8410
                 8415 WRITE ( 6,1020 )
                      DO 8420 K = 1,61
                 8420 AKIL(K,J) = AKIL(K,J) / SAMP
1355                  WRITE ( 6,8430) ( AKIL(K,J),K=1,61 )
                 8430 FORMAT ( 11X,10F8.5 )
                 8410 CONTINUE
                      WRITE ( 6,1010 )
                 9000 CONTINUE
1360                  IF ( ISTMOV .EQ. 1 ) GO TO 9305
                 9010 IF ( ISPLIT .EQ. 4 ) ISPLIT = 0
                      IF ( ISPLIT .NE. 2 ) GO TO 9100
                      NANGLE = NANGLE - 1
                      IF ( NRANGE .EQ. 1 ) NEJECT = 1
1365                  GO TO 3000
                 9100 CONTINUE
                      IF ( NSTCRD .GT. 0 ) GO TO 9302
                      NANGLE = NANGLE + 1
```

FRACTION OF ALL ENGAGEMENTS IN WHICH TARGET WAS HIT OR KILLED BY FIRST OR SECOND ROUND, DIFFERENCE Z(2,K)-Z(1,K) REPRESENTS FRACTION OF ALL ENGAGEMENTS IN WHICH ACHIEVING HIT OR KILL REQUIRED EXACTLY TWO ROUNDS. FOR I EQUAL TO 3, SMIK EQUALS ITS PREVIOUS VALUE PLUS TERM 3(Z(3,K)-Z(2,K)). EVENTUALLY SMIK ACCOUNTS FOR ALL OF FIRST NRDS ROUNDS. FURTHER CALCULATING IS UNNEEDED IF Z(NRDS,K) IS EQUAL TO 1 OR VERY NEARLY SO, INDICATING THAT NRDS OR FEWER ROUNDS SUFFICED IN ALL OR PRACTICALLY ALL SAMPLE ENGAGEMENTS. IN THAT CASE AVERAGE NUMBER OF ROUNDS AV EQUALS SMIK.

1333-1340 APPLY APPROXIMATE AND RATHER INTRICATE EXTRAPOLATION FORMULA TO ACCOUNT FOR ENGAGEMENTS WHERE NRDS OR FEWER ROUNDS DID NOT SUFFICE TO HIT OR KILL TARGET. FORMULA IS BASED ON CONDITIONAL PROBABILITIES OF HIT OR CONDITIONAL PROBABILITIES OF KILL. SUCH CONDITIONAL PROBABILITIES HAVE NOT BEEN INVOLVED SO FAR IN PROGRAM CALCULATIONS BUT ARE INFERRABLE FROM PROBABILITIES IN Z ARRAY. IF NRDS IS NOT TOO SMALL, CONDITIONAL PROBABILITIES FOR EACH ROUND FOLLOWING FIRST NRDS ROUNDS CAN BE CONSIDERED APPROXIMATELY EQUAL TO AVERAGE OF FIVE CONDITIONAL PROBABILITIES APPLYING TO LAST FIVE OF FIRST NRDS ROUNDS. LOWER BOUND OF 10 FOR NRDS HAS BEEN CHOSEN AS ACCEPTABLE IN THIS CONTEXT. AZ REPRESENTS AVERAGE NUMBER OF ROUNDS NEEDED IN ADDITION TO FIRST NRDS ROUNDS WHEN NRDS ROUNDS ARE INSUFFICIENT. CORRESPONDING FRACTION OF ENGAGEMENTS IS INDICATED BY DIFFERENCE 1.0-Z(NRDS,K). AVERAGE NUMBER OF ROUNDS AV IS OBTAINED BY ADDING SMIK VALUE ASSOCIATED WITH ENGAGEMENTS WHERE NRDS ROUNDS SUFFICE AND PRODUCT ACCOUNTING FOR ALL OTHER ENGAGEMENTS.

1341 PRIMARILY TO AVOID HAVING TO PRINT VERY LARGE NUMBERS, REPLACE ANY NUMBER LARGER THAN 999 BY THIS LIMIT. THERE IS OF COURSE NO PRACTICAL INTEREST IN MANY AVERAGE NUMBERS OF ROUNDS THAT ARE MUCH SMALLER THAN 999 BUT STILL TOO LARGE TO CORRESPOND TO REALISTIC COMBAT ENGAGEMENT SITUATIONS.

1346-1357 CALCULATE AVERAGE VALUES PER SAMPLE ENGAGEMENT FOR EACH QUANTITY IN AKIL ARRAY. CONSIDER ONLY FIRST HIT ON TARGET WHEN NPRHIT EQUALS 1. RESULTING AVERAGE AKIL(K,J) VALUES CAN BE INTERPRETED AS CORRESPONDING PROBABILITIES OF HITTING OR KILLING TARGET BEFORE 2(K-1) SECONDS.

1360 SKIP PROGRAM LINES 1361 THROUGH 1369 FOR MOVING TARGET OR MOVING FIRING WEAPON RUN.

1361 SINCE CALCULATIONS INVOLVING RANGE INTERPOLATION OF TARGET VULNERABILITY DATA HAVE BEEN COMPLETED, RESET ISPLIT TO INITIAL SETTING.

1362-1365 PROGRAM LINES 1363 THROUGH 1365 APPLY ONLY IF ISPLIT IS 2. CALCULATIONS FOR FIRST PART OF SIMULATIONS HAVE JUST BEEN COMPLETED FOR REVERSE ANGLE OF CONCERN AND NANGLE NEEDS TO BE RESET BEFORE SECOND PART OF SIMULATIONS FOR CORRESPONDING FORWARD ANGLE. NEJECT IS ASSOCIATED WITH LINE SKIPPING OCCASIONALLY NEEDED WHEN TARGET VULNERABILITY DATA ARE READ FROM TAPE OR DISC. CONTINUE AT PROGRAM STATEMENT 3000.

1367 SKIP PROGRAM LINES 1368 THROUGH 1370 IF RUN INVOLVES TARGET SHAPE DATA FROM CARDS.

1368-1370 CONTINUE EITHER AT PROGRAM STATEMENT 4020 FOR NEXT VALUE OF NANGLE IF ANY OR AT STATEMENT 9310.

1371-1374 IF RUN INVOLVES TARGET SHAPE DATA FROM CARDS, CONTINUE AT PROGRAM STATEMENT 4210 FOR NEXT NTRGTC VALUE OF CONCERN OR AT STATEMENT 9310.

1375-1379 APPLICABLE FOR MOVING TARGET OR MOVING FIRING WEAPON RUN ONLY. MSET EQUALS 1 THROUGH 6 FOR VARIOUS TARGET SPEED AND EVASIVE MANEUVERING CONDITIONS. NANGLE VALUES FOR MOVING TARGET OR MOVING FIRING WEAPON RUN ARE RESTRICTED TO 1 FOR 0 DEGREES, 3 FOR 30 DEGREES, AND 5 FOR 60 DEGREES. CONTINUE AT PROGRAM STATEMENT 4035 IF ALL SIX MSET VALUES HAVE BEEN CONSIDERED.

```
                IF ( NANGLE .LE. 8 ) GO TO 4020
1370            GO TO 9310
             9302 NTRGTC = NTRGTC + 1
                IF ( NTRGTC .GT. 4 ) GO TO 9310
                IF ( KTRGTC(NTRGTC) .GT. 0 ) GO TO 4210
                GO TO 9310
1375         9305 MSET = MSET + 1
                IF ( MSET .LE. 6 ) GO TO 4035
                MSET = 1
                NANGLE = NANGLE + 2
                IF ( NANGLE .LE. 5 ) GO TO 4020
1380         9310 NRANGE = NRANGE + 1
                IF ( NRDTYP .EQ. 1 .AND. NEJECT .EQ. 0 ) NEJECT = 1
                IF ( NRANGE .LE. NCASES ) GO TO 2010
             9900 CONTINUE
                CALL EXIT
1385            END
```

```
   1            SUBROUTINE NRAN(R1,R2)
                A = SQRT(-2.0*ALOG(RANF(X)))
                B = 6.28318530718 * RANF(X)
                R1 = A * SIN(B)
   5            R2 = A * COS(B)
                RETURN
                END
```

```
   1            FUNCTION CNORM(X)
                F = 0.0
                AX = ABS(X)
                IF ( AX .GE. 5.0 ) GO TO 10
   5            F = (((((0.5383E-5*AX+0.488906E-4)*AX+0.380036E-4)*AX+0.0032776263
               A    )*AX+0.0211410061)*AX+0.0498673469)*AX + 1.0
                F = .5 / ((F**8)**2)
              10 IF ( X .GE. 0.0 ) F = 1.0 - F
                 CNORM = F
  10            RETURN
                END
```

OTHERWISE RESET MSET TO INITIAL SETTING BEFORE CONTINUING AT STATEMENT 4020 OR 9310 ACCORDING TO WHETHER CALCULATIONS HAVE OR HAVE NOT YET BEEN DONE FOR ALL THREE NANGLE VALUES OF CONCERN.

1380-1382 CONTINUE AT PROGRAM STATEMENT 2010 UNLESS CALCULATIONS FOR LAST RANGE HAVE JUST BEEN COMPLETED. NEJECT MAY NEED TO BE RESET WHEN TARGET VULNERABILITY DATA FROM TAPE OR DISC ARE INVOLVED.

1383-1385 RUN STOPS, POSSIBLY PREMATURELY IF PROBLEM HAS OCCURRED.

SUBROUTINE NRAN(R1,R2) PRODUCES PAIR OF RANDOM NORMAL DEVIATES R1 AND R2 FROM NORMAL DISTRIBUTION WITH MEAN OF 0 AND STANDARD DEVIATION OF 1.

WHEN X EQUALS (X2-BX(N))/SIGX(K,N), FOR EXAMPLE, FUNCTION CNORM(X) CALCULATES PROBABILITY OF RANDOM VARIABLE LYING BETWEEN MINUS INFINITY AND X2 FOR NORMAL DISTRIBUTION WITH BIAS OF BX(N) AND STANDARD DEVIATION OF SIGX(K,N).

APPENDIX B

EXPLANATIONS OF PROGRAM STATEMENTS 919 THROUGH 1131

EXPLANATIONS OF PROGRAM STATEMENTS 919 THROUGH 1131

This appendix contains a paper presented, in early 1979, at the Army Numerical Analysis and Computers Conference. This paper, entitled "A FORTRAN ROUTINE FOR ESTIMATING NORMAL DISTRIBUTION PARAMETERS", provides detailed explanations of program lines 919 through 1131 of the direct fire program.

The paper was subdivided into three parts, namely, the introduction, the description of the basic mathematical procedure, and the conclusion. The contents of these three parts follow.

1. INTRODUCTION. A Monte Carlo computer program simulating the engagement of a single target by a tank main armament system has been developed by the Joint Munitions Effectiveness Manual (JMEM) Methodology and Evaluations Working Group, a tri-service group responsible for establishing certain standardized estimates of weapon effectiveness. The program is often referred to as the JMEM Direct Fire program. Exercise of this program yields large amounts of data concerning the location of round impacts in the target plane. First rounds fired against a particular target are of chief concern, and these can be subdivided into rounds that hit and rounds that miss the target. Chart 1 illustrates a possible target and a few conceivable first round impact points.

This paper describes a computer routine for processing the horizontal coordinates or the vertical coordinates of hitting rounds or of missing rounds. The routine provides, for each set of data considered, an estimate of the mean and three estimates of the standard deviation for a normal distribution tentatively assumed to fit the data. After the computer run, an analyst can judge by comparing the three standard deviation values whether the tentative assumption of normality is sufficiently substantiated and, if so, make a best estimate for the parameters of interest. The word "routine" is used for the logical processing documented in this paper. However, the associated program statements have not actually been structured as a separate routine, but are a portion of the complete engagement simulation program previously mentioned. A separate routine could readily be developed for other applications.

2. DESCRIPTION OF ROUTINE. The program instructions of interest are listed in Chart 2. Note that the entire chart consists of the loop DO 7010 I = 1,2. The index I equals 1 for horizontal coordinates and 2 for vertical coordinates. For any other application, one could allow for more values of I or establish a single dummy setting for this index.

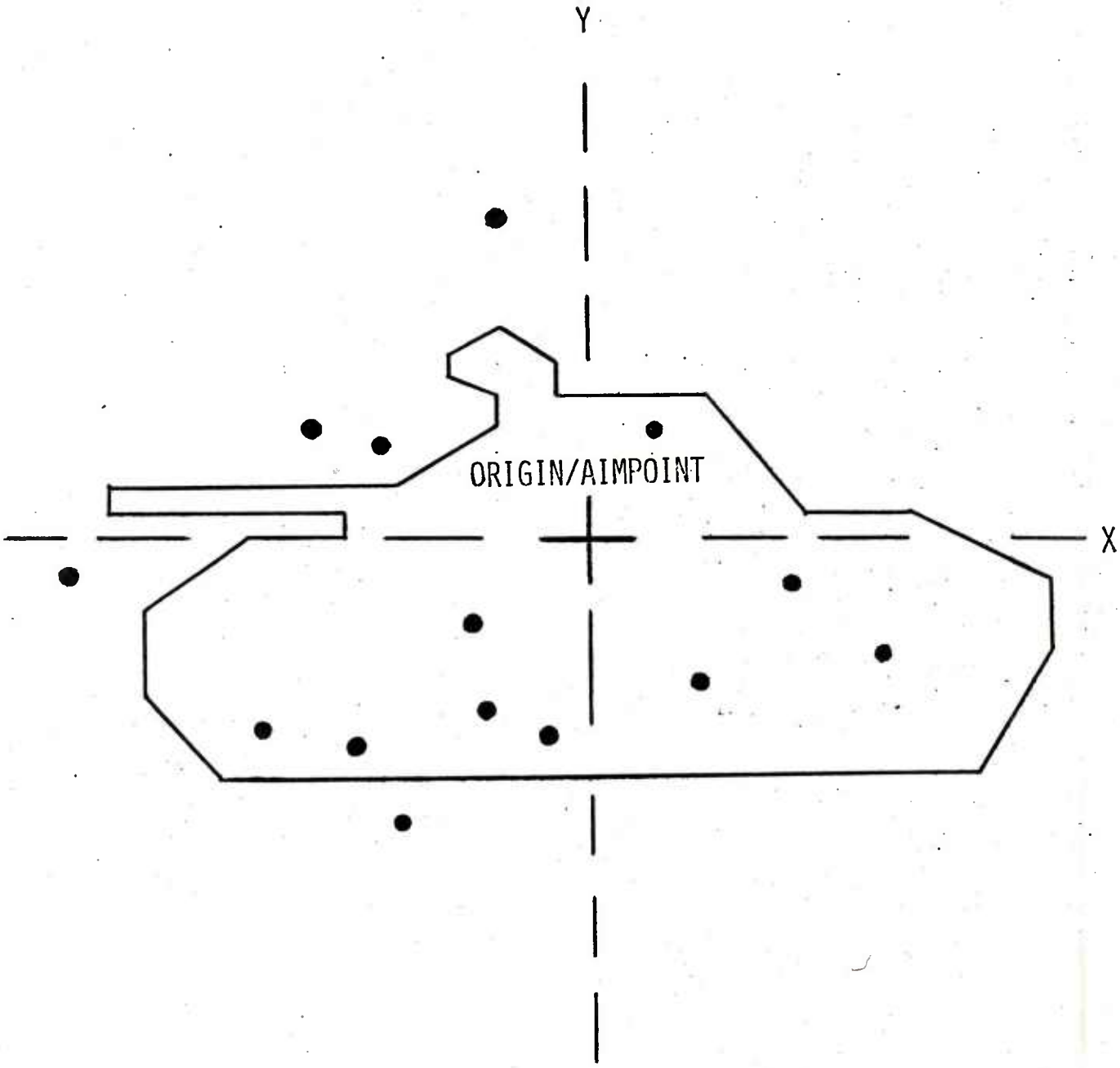


CHART 1 IMPACT POINTS FOR HITTING AND MISSING FIRST ROUNDS

```
      DO 7010 I = 1,2
      AVRG = 0.0
      TMINUS = 0.0
      TPLUS = 0.0
      KTIMES = 0
      DO 7020 J = 1,50
      TERM1 = NMINUS(J,I,N)
      TERM2 = NPLUS(J,I,N)
      TMINUS = TMINUS + TERM1
7020  TPLUS = TPLUS + TERM2
      TOTAL(I) = TMINUS + TPLUS
      NTOTAL = TOTAL(I)
      T5000 = TOTAL(I) * 0.5
      N5000 = T5000
      IF ( T5000 .NE. TMINUS ) GO TO 7024
      DO 7022 K = 1,50
      NPOS(K) = NPLUS(K,I,N)
7022  NNEG(K) = NMINUS(K,I,N)
      GO TO 7200
7024  IF ( T5000 .LT. TMINUS ) GO TO 7025
      DIFF = T5000 - TMINUS
      DO 7030 J = 1,50
      PLUS = NPLUS(J,I,N)
      IF ( PLUS .LT. DIFF ) GO TO 7035
      IFRCTN = 1000.0 * DIFF / PLUS
      FRCTN = FLOAT(IFRCTN) / 1000.0
      AVRG = AVRG + FRCTN*20.0
      JEND = 100 - KTIMES
      LTIMES = 50 - KTIMES
      LEND = 1 + KTIMES
      DO 7040 K = 1,50
      NNEG(K) = 0
7040  NPOS(K) = 0
      NCMLTN = 0
      NCMLTP = 0
      L = 0
7050  IF ( L .EQ. 100 ) GO TO 7200
      L = L + 1
      LL = L
      IF ( L .LE. 50 ) LL = 51 - L
      M = L
      IF ( L .GT. 50 ) M = L - 50
      IF ( LL .LE. JEND ) GOTO 7055
      NPOS(M) = 0
      GO TO 7060
7055  IF ( LL .LT. JEND ) GOTO 7065
      NTERM = (IFRCTN*NPLUS(50,I,N)+500) / 1000
      NPOS(M) = NPLUS(50,I,N) - NTERM
      NCMLTP = NCMLTP + NPOS(M)
      GO TO 7060
7065  IF ( LL .LE. LTIMES ) GOTO 7075
      IF ( LL .LE. 50 ) GOTO 7070
```

CHART 2 PROGRAM STATEMENTS (CONTINUED)

```
      NTERM1 = (IFRCTN*NPLUS(L-LTIMES,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NPLUS(L-LTIMES+1,I,N)+500) / 1000
      NPOS(M) = NPLUS(L-LTIMES,I,N) - NTERM1 + NTERM2
      NCMLTP = NCMLTP + NPOS(M)
      GO TO 7060
7070  NTERM1 = (IFRCTN*NPLUS(LEND-M,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NPLUS(LEND-M+1,I,N)+500) / 1000
      NNEG(M) = NPLUS(LEND-M,I,N) - NTERM1 + NTERM2
      NCMLTN = NCMLTN + NNEG(M)
      GO TO 7060
7075  IF ( LL .LT. LTIMES ) GOTO 7085
      NTERM1 = (IFRCTN*NMINUS(1,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NPLUS(1,I,N)+500) / 1000
      NNEG(M) = NMINUS(1,I,N) - NTERM1 + NTERM2
      NCMLTN = NCMLTN + NNEG(M)
      GO TO 7060
7085  IF ( LL .EQ. 1 ) GO TO 7095
      NTERM1 = (IFRCTN*NMINUS(LTIMES-LL+1,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NMINUS(LTIMES-LL,I,N)+500) / 1000
      NNEG(L-KTIMES+1) = NMINUS(LTIMES-LL+1,I,N) - NTERM1 + NTERM2
      NCMLTN = NCMLTN + NNEG(L-KTIMES+1)
      GO TO 7060
7095  NNEG(50) = (IFRCTN*NMINUS(49-KTIMES,I,N)+500) / 1000
      NXTRA = KTIMES + 1
      DO 7100 JXTRA = 1,NXTRA
7100  NNEG(50) = NNEG(50) + NMINUS(49-KTIMES+JXTRA,I,N)
      NTERM = (IFRCTN*NMINUS(50,I,N)+500) / 1000
      NNEG(50) = NNEG(50) + NTERM
      NCMLTN = NCMLTN + NNEG(50)
7060  IF ( NCMLTP .EQ. NTOTAL ) L = 100
      IF ( L .GT. 50 ) GO TO 7050
      IF ( NCMLTN .LT. N5000 ) GO TO 7050
      NCMLTP = NCMLTN
      L = 50
      GO TO 7050
7035  DIFF = DIFF - PLUS
      KTIMES = KTIMES + 1
      AVRG = AVRG + 20.0
7030  CONTINUE
7025  DIFF = TMINUS - T5000
      DO 7110 J = 1,50
      AMINUS = NMINUS(J,I,N)
      IF ( AMINUS .LT. DIFF ) GO TO 7115
      IFRCTN = 1000.0 * DIFF / AMINUS
      FRCTN = FLOAT(IFRCTN) / 1000.0
      AVRG = AVRG - FRCTN*20.0
      JEND = 100 - KTIMES
      LTIMES = 50 - KTIMES
      LEND = 1 + KTIMES
      DO 7120 K = 1,50
      NPOS(K) = 0
7120  NNEG(K) = 0
      NCMLTP = 0
      NCMLTN = 0
      L = 0
7130  IF ( L .EQ. 100 ) GO TO 7200
      L = L + 1
```

```
      LL = L
      IF ( L .LE. 50 ) LL = 51 - L
      M = L
      IF ( L .GT. 50 ) M = L - 50
      IF ( LL .LE. JEND ) GOTO 7135
      NNEG(M) = 0
      GO TO 7140
7135  IF ( LL .LT. JEND ) GOTO 7145
      NTERM = (IFRCTN*NMINUS(50,I,N)+500) / 1000
      NNEG(M) = NMINUS(50,I,N) - NTERM
      NCMLTN = NCMLTN + NNEG(M)
      GO TO 7140
7145  IF ( LL .LE. LTIMES ) GOTO 7155
      IF ( LL .LE. 50 ) GOTO 7150
      NTERM1 = (IFRCTN*NMINUS(L-LTIMES,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NMINUS(L-LTIMES+1,I,N)+500) / 1000
      NNEG(M) = NMINUS(L-LTIMES,I,N) - NTERM1 + NTERM2
      NCMLTN = NCMLTN + NNEG(M)
      GO TO 7140
7150  NTERM1 = (IFRCTN*NMINUS(LEND-M,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NMINUS(LEND-M+1,I,N)+500) / 1000
      NPOS(M) = NMINUS(LEND-M,I,N) - NTERM1 + NTERM2
      NCMLTP = NCMLTP + NPOS(M)
      GO TO 7140
7155  IF ( LL .LT. LTIMES ) GOTO 7165
      NTERM1 = (IFRCTN*NPLUS(1,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NMINUS(1,I,N)+500) / 1000
      NPOS(M) = NPLUS(1,I,N) - NTERM1 + NTERM2
      NCMLTP = NCMLTP + NPOS(M)
      GO TO 7140
7165  IF ( LL .EQ. 1 ) GO TO 7175
      NTERM1 = (IFRCTN*NPLUS(LTIMES-LL+1,I,N)+500) / 1000
      NTERM2 = (IFRCTN*NPLUS(LTIMES-LL,I,N)+500) / 1000
      NPOS(L-KTIMES+1) = NPLUS(LTIMES-LL+1,I,N) - NTERM1 + NTERM2
      NCMLTP = NCMLTP + NPOS(L-KTIMES+1)
      GO TO 7140
7175  NPOS(50) = (IFRCTN*NPLUS(49-KTIMES,I,N)+500) / 1000
      NXTRA = KTIMES + 1
      DO 7180 JXTRA = 1,NXTRA
7180  NPOS(50) = NPOS(50) + NPLUS(49-KTIMES+JXTRA,I,N)
      NTERM = (IFRCTN*NPLUS(50,I,N)+500) / 1000
      NPOS(50) = NPOS(50) + NTERM
      NCMLTP = NCMLTP + NPOS(50)
7140  IF ( NCMLTN .EQ. NTOTAL ) L = 100
      IF ( L .GT. 50 ) GO TO 7130
      IF ( NCMLTP .LT. N5000 ) GO TO 7130
      NCMLTN = NCMLTP
      L = 50
      GO TO 7130
7115  DIFF = DIFF - AMINUS
      KTIMES = KTIMES + 1
      AVRG = AVRG - 20.0
7110  CONTINUE
7200  CONTINUE
      DO 7310 K = 1,50
      IF ( K .GT. 1 ) GO TO 7315
      NSUM1 = NPOS(K)
```

CHART 2 PROGRAM STATEMENTS (CONTINUED)

```
      NSUM2 = NNEG(K)
      GO TO 7320
7315  NSUM1 = NSUM1 + NPOS(K)
      NSUM2 = NSUM2 + NNEG(K)
7320  NCMPOS(K) = NSUM1
      NCMNEG(K) = NSUM2
      NRFLCT(K) = NSUM1 + NSUM2
7310  CONTINUE
      DO 7330 J = 1,50
      SIGMAX = J * 20
      IF ( J .GT. 1 ) GO TO 7335
      SMFRQ1 = 0.0
      SMFRQ2 = NRFLCT(1) * 10000 / NTOTAL
      K5 = 5
      K10 = 10
      GO TO 7350
7335  SMFRQ1 = SMFRQ2
      IF ( J .EQ. 50 ) GO TO 7345
      SMFRQ2 = NRFLCT(J) * 10000 / NTOTAL
      GO TO 7350
7345  SMFRQ2 = 10000.0
7350  FRQNCY = SMFRQ2 - SMFRQ1
      IF ( K5 .NE. 5 ) GO TO 7355
      IF ( SMFRQ2 .LT. 3829.2 ) GOTO 7330
      D05 = (SMFRQ2-3829.2) / FRQNCY
      SIG05 = (SIGMAX-D05*20.0) / 0.5
      K5 = 0
7355  IF ( K10 .NE. 10 ) GO TO 7365
      IF ( SMFRQ2 .LT. 6826.8 ) GOTO 7330
      D10 = (SMFRQ2-6826.8) / FRQNCY
      SIG10 = SIGMAX - D10*20.0
      K10 = 0
7365  IF ( SMFRQ2 .LT. 8663.8 ) GOTO 7330
      D15 = (SMFRQ2-8663.8) / FRQNCY
      SIG15 = (SIGMAX-D15*20.0) / 1.5
      GO TO 7370
7330  CONTINUE
7370  WRITE ( 6,1020 )
      WRITE ( 6,7380) N,I,SIG05,SIG10,SIG15
7380  FORMAT ( 10X,26H N,I,SIG05,SIG10,SIG15     ,2I10,3F10.4 )
      BIASXY(I,N) = AVRG
      IF ( I .EQ. 1 ) SSQRRE = SIGXL**2 + SIGXR**2
      IF ( I .EQ. 2 ) SSQRRE = SIGYL**2 + SIGYR**2
      SIGMXY(1,I,N) = SQRT(SIG05**2+SSQRRE)
      SIGMXY(2,I,N) = SQRT(SIG10**2+SSQRRE)
      SIGMXY(3,I,N) = SQRT(SIG15**2+SSQRRE)
7010  CONTINUE
```

The index N is set before the DO 7010 loop and presently has possible values of 1 through 5. N equals 1 when hitting first rounds are of concern and 3 for missing first rounds. Meanings of the values 2, 4, and 5 need not be explained here. The range of values of N can, for other applications, be increased or decreased; in particular, a single dummy setting can be used.

The horizontal and vertical coordinate axes are each subdivided into 100 intervals of 20 inches each; positive and negative coordinates are each covered by 50 intervals. Intervals are related to the index J in a way that should soon be clear. Assume that one has run many simulated engagements and determined, for hitting rounds and missing rounds separately, how many times a particular interval contained the horizontal coordinate of the first round and, again separately, the vertical coordinate. Input data of this sort are shown in Chart 3. Numbers in the array NPLUS(J,I,N) indicate how many coordinates are within the interval 0 to 20 inches for J = 1, within the interval 20 to 40 inches for J = 2, and so forth. Similarly, the NMINUS(J,I,N) array contains the number of coordinates within the interval -20 to 0 inches for J = 1, and so forth.

The arrays involved in Chart 2 and their dimensions in the JMEM Direct Fire program are as follows:

```
NMINUS(50,2,5)
NPLUS(50,2,5)
TOTAL(2)
NNEG(50)
NPOS(50)
NCMPOS(50)
NCMNEG(50)
NRFLCT(50)
```

The NMINUS and NPLUS arrays contain the data to be processed.

The complete calculations for particular values of N and I yield an estimate of the mean, denoted by AVRG, and three estimates of the standard deviation, represented by SIG05, SIG10, and SIG15.

A total of 1000 engagements were simulated to obtain the data in Chart 3. A first round hit was obtained in 529 instances, and the first round missed the target in the other 471 instances. The impact points for the 529 hits were (for an observer at the firing weapon) to the right of the Y-axis illustrated in Chart 1 on 324 occasions, and to the left on the other 205 occasions. These same impact points were above the X-axis 198 times and below 331 times. Impact points of the 471 misses had positive horizontal coordinates in 278 engagements, and positive vertical coordinates in 369 engagements. To illustrate the remainder of these explanations, an arbitrary choice has been made of the values N = 3 (missing first rounds) and I = 2 (vertical coordinates).

It is useful to digress and consider how the mean and standard deviation of a normal distribution corresponding to the input data selected can be estimated graphically. Chart 4 shows the associated quantitative basis and Chart 5 the plotted points to which one would attempt, using judgement rather than calculation, to fit a straight line. The computer routine being described performs computations that basically parallel the graphical approach.

CHART 3 SAMPLE INPUT DATA

J	INTERVAL (INCHES)		N = 1 I = 1	N = 1 I = 2	N = 3 I = 1	N = 3 I = 2
			(205)	(331)	(193)	(102)
8			0	0	0	0
7			0	0	0	0
6			0	0	0	3
5			2	1	0	14
4			11	17	12	29
3			34	50	21	19
2			65	118	59	17
1			93	145	101	20
1	0-20		140	109	96	71
2	20-40		100	71	81	104
3	ETC		55	17	54	104
4			21	1	35	58
5			8	0	8	19
6			0	0	2	11
7			0	0	2	2
8			0	0	0	0
			(324)	(198)	(278)	(369)
			(529)	(529)	(471)	(471)

NMINUS (J, I, N)

NPLUS (J, I, N)

CHART 4 BASIS FOR CHART 5

N=3, I=2

J	NMINUS (J, I, N)	CUMULATIVE SUM	CUMULATIVE FRACTION (SUM/471)
6	3	3	.006
5	14	17	.04
4	29	46	.10
3	19	65	.14
2	17	82	.17
1	20	102	.22
1	71	173	.37
2	104	277	.59
3	104	381	.81
4	58	439	.93
5	19	458	.97
6	11	469	.996
7	2	471	1.000

NPLUS (J, I, N)

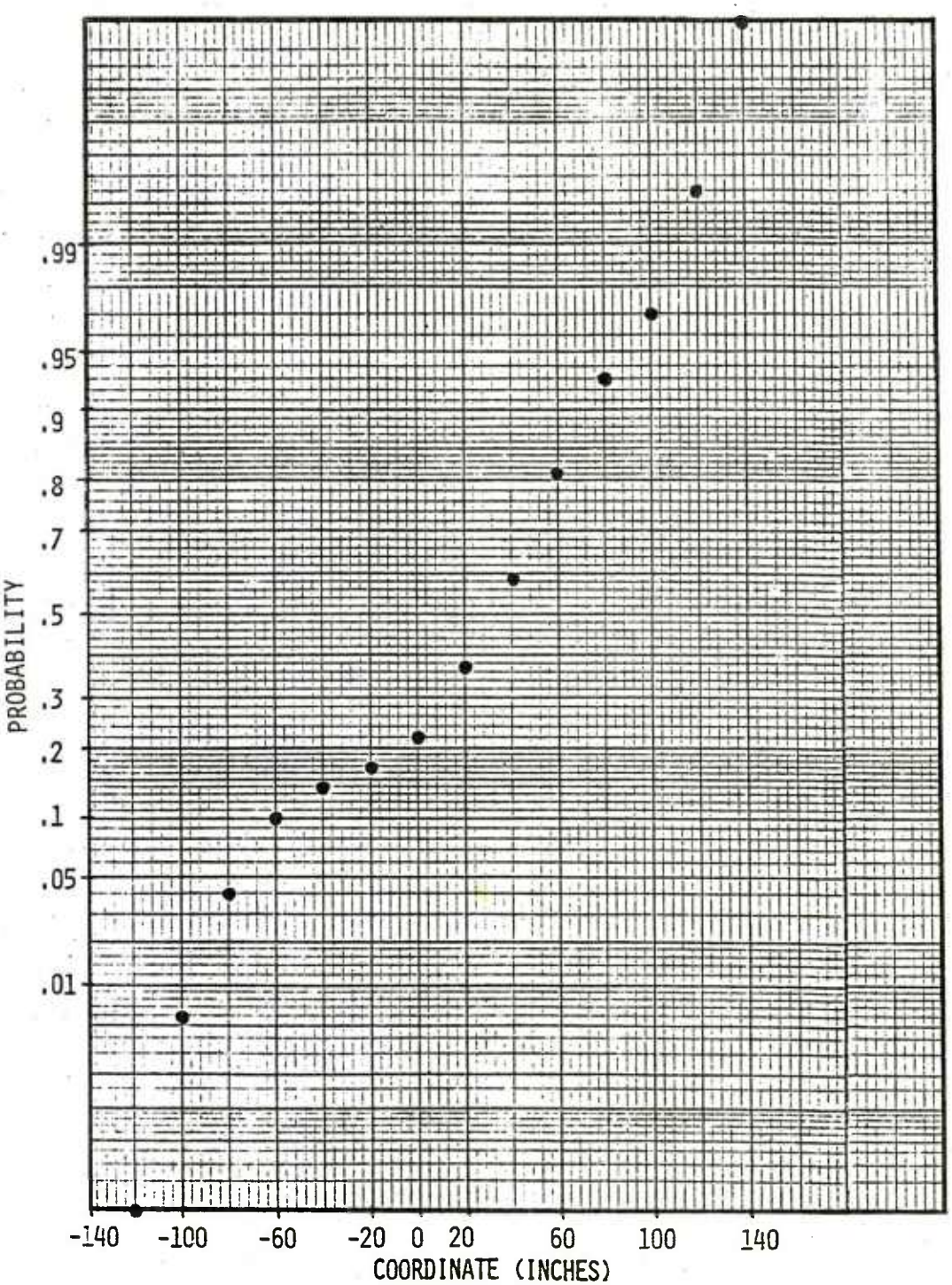


CHART 5 DISTRIBUTION OF COORDINATE DATA

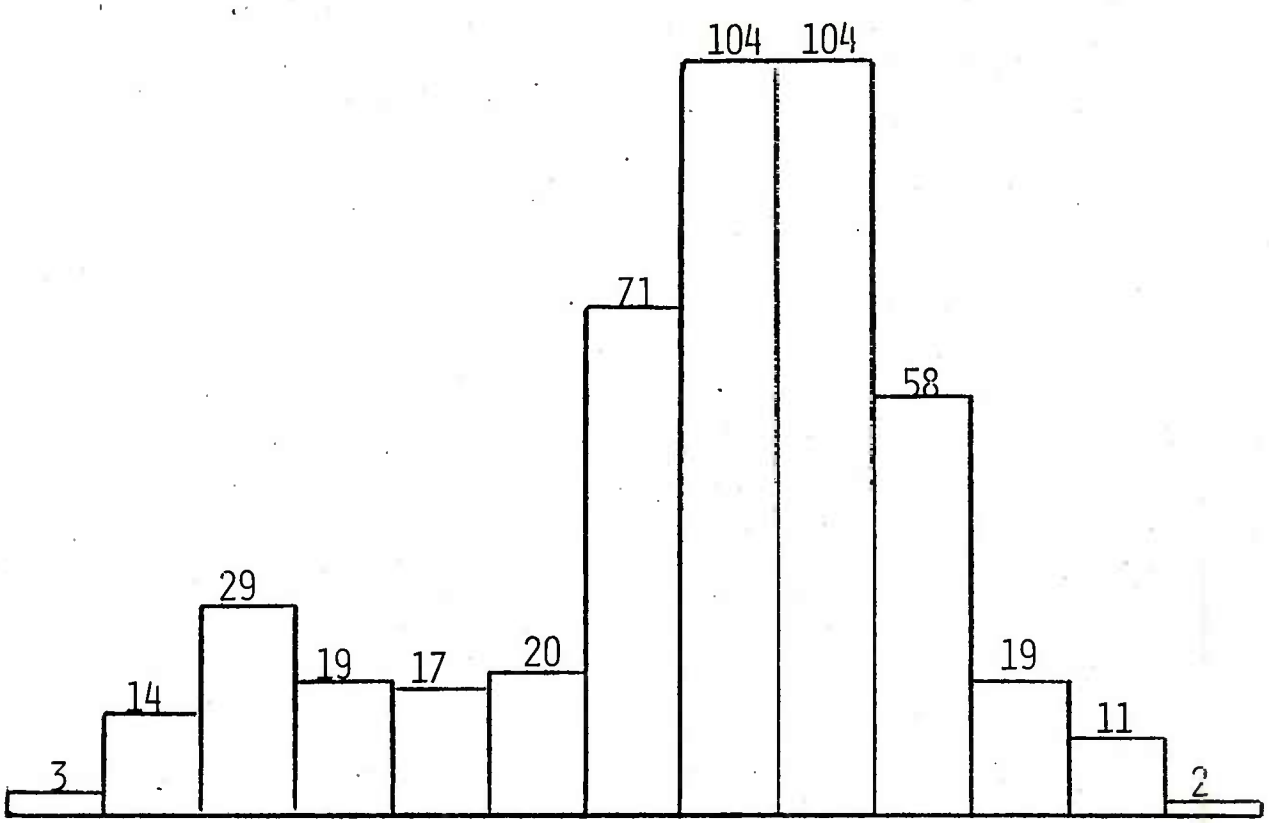
The steps involved in estimating the mean are illustrated in Chart 6. Note that, for this example, the nonzero input data of concern are NPLUS(1,I,N) = 71, NPLUS(2,I,N) = 104, . . ., NPLUS(7,I,N) = 2, NMINUS(1,I,N) = 20, . . ., NMINUS (6,I,N) = 3. The totals 102 and 369 are the values of TMINUS and TPLUS after completion of the DO 7020 loop. Since TPLUS exceeds TMINUS, the program attempts to identify a positive value on the Y-axis as the estimate of the mean. Consequently, DIFF is calculated by the statement right before the DO 7030 loop, rather than by the statement preceding the DO 7110 loop. The DO 7030 loop establishes first that the point of central tendency is at least as great as 20 inches, the right end of the first interval considered. This is so because 133 impact point coordinates need to be dropped from the NPLUS group before the coordinates equal half of NTOTAL. Since the 71 coordinates in NPLUS(1,I,N) are less than 133, KTIMES is reset to 1 and the difference is reduced to 62. Next, the DO 7030 loop determines that .6 of the 104 coordinates in the interval 20 to 40 inches need to be dropped. Since .6 times 20 equals 12, the points to be dropped are simply assumed to be located in the interval 20 to 32 inches, while all other points in the interval 20 to 40 inches are considered to exceed 32. One can observe in Chart 7 that the calculated value of AVRG corresponds to the point where one of the line segments joining adjacent points crosses the .5 probability level.

Once the mean is known, the next step is to relate the original input data to a new set of 20-inch intervals centered about the mean. Chart 8 illustrates how this is done. Each NMINUS(J,I,N) and NPLUS(J,I,N) value is first subdivided into two subelements according to the value of FRCTN. For example, NMINUS(6,I,N) is broken up into 2, associated with the 12 inches to the left, and 1, considered in the right 8 inches of the interval -100 to -120 inches. Subelements from adjacent intervals are then paired appropriately and added to get NNEG(M) and NPOS(M) values, where the index M is associated with the adjusted set of intervals. Note how NPLUS(2,I,N), which involves the original interval containing the estimated mean 32, contributes 62 to NNEG(1) and 42 to NPOS(1). The cumulative totals MCMLTN and NCMLTP, where NCMLTP always includes the maximum value of NCMLTN, enable the computer to determine when all the original nonzero input information has been processed. The interval adjustment just described is done by the statements beginning with JEND = 100 - KTIMES that follow the final determination of AVRG in the DO 7030 loop, or in the DO 7110 loop.

After the interval adjustment calculations have been completed, the DO 7310 loop of the program computes the values in the NRFLCT array as shown in Chart 9. The NRFLCT array represents an equal weight combination of the NPOS and NNEG data. Any NRFLCT(K) value indicates how often the absolute values of the differences between the vertical coordinates of missing first rounds and the estimated mean are equal to or less than 20 K inches. The fractions obtained when one divides the NRFLCT values by NTOTAL are not calculated by the program, but are included in Chart 9. Chart 10 illustrates how these fractions are related to the distribution of concern.

The DO 7330 loop determines the three alternative estimates for the standard deviation. These estimates are based on the probabilities associated in a normal distribution with the mean plus or minus 0.5 standard deviation, plus or minus 1.0 standard deviation, and plus or minus 1.5 standard deviation. Linear interpolation is applied, as necessary, to the distribution implied by the NRFLCT values to infer estimates of 0.5, 1.0, and 1.5 times the standard

CHART 6 CALCULATION OF MEAN



TMINUS = 102.

TPLUS = 369.

NTOTAL = 471

N5000 = 235

DIFF = 133.

71. < 133.

KTIMES = 1

DIFF = 62.

104. > 62.

FRCTN = .6

AVRG = 32.0

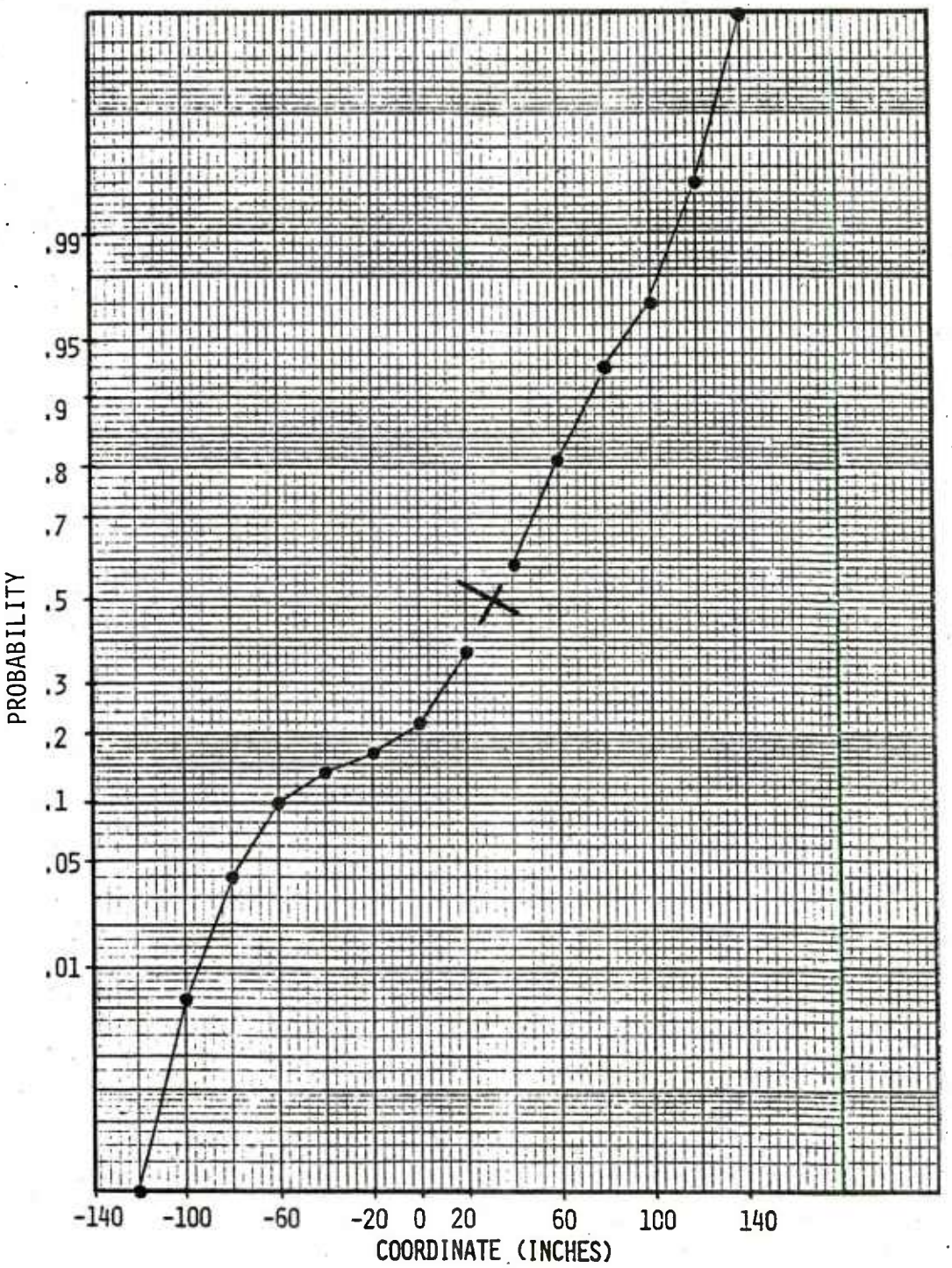


CHART 7 ESTIMATED MEAN (AVRG)

CHART 8 ADJUSTMENT OF INTERVALS

N=3, I=2

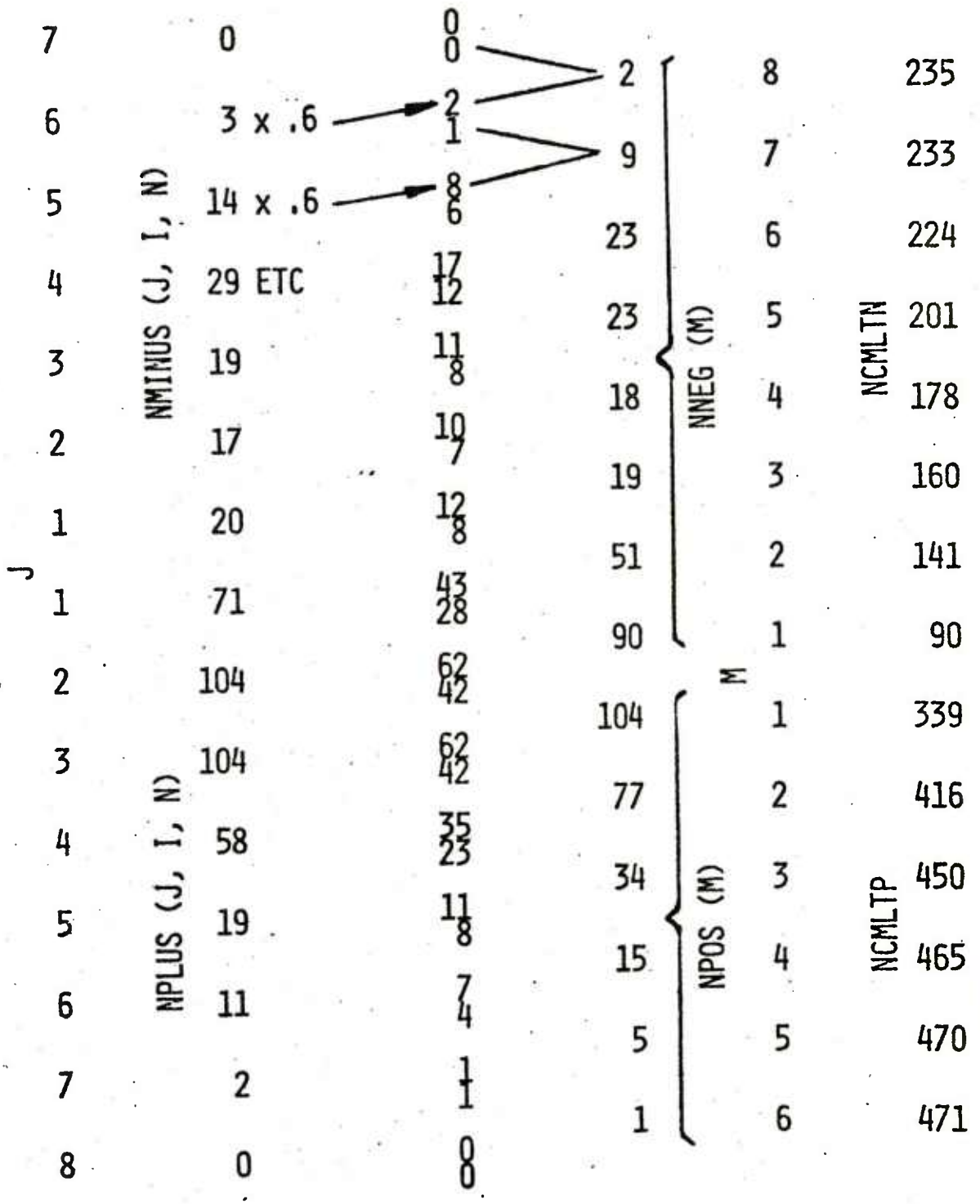


CHART 9 CALCULATION OF NRFLCT AND CORRESPONDING FRACTIONS

K	NNEG (K)	NCMNEG (K)	NPOS (K)	NCMPOS (K)	NRFLCT (K)	NRFLCT(K)/471
8	2	235				
7	9	233				
6	23	224				
5	23	201				
4	18	178				
3	19	160				
2	51	141				
1	90	90				
1			104	104	194	.412
2			77	181	322	.684
3			34	215	375	.796
4			15	230	408	.866
5			5	235	436	.926
6			1	236	460	.977
7			0	236	469	.996
8			0	236	471	1.000

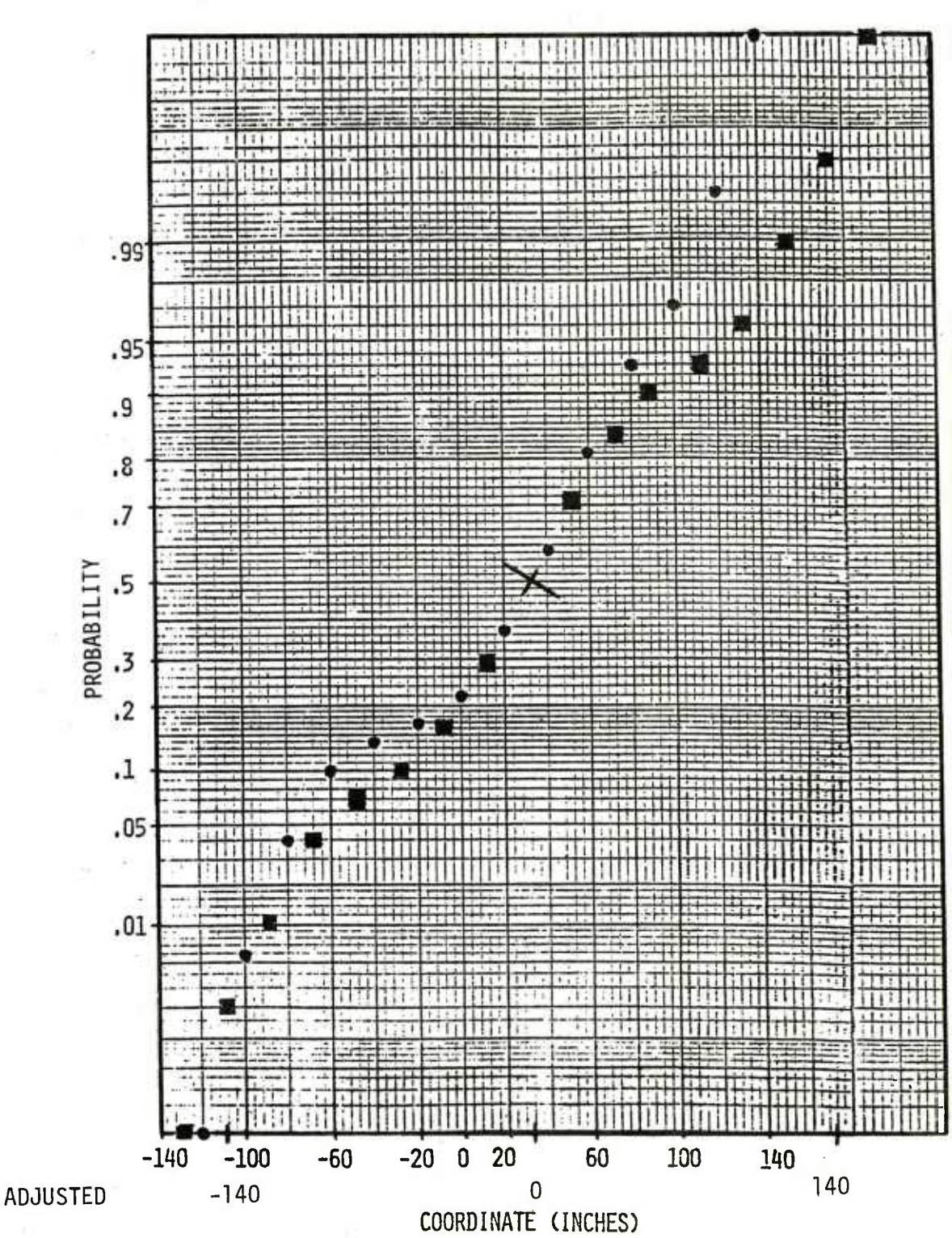


CHART 10 FRACTIONS BASED ON NRFLCT VALUES

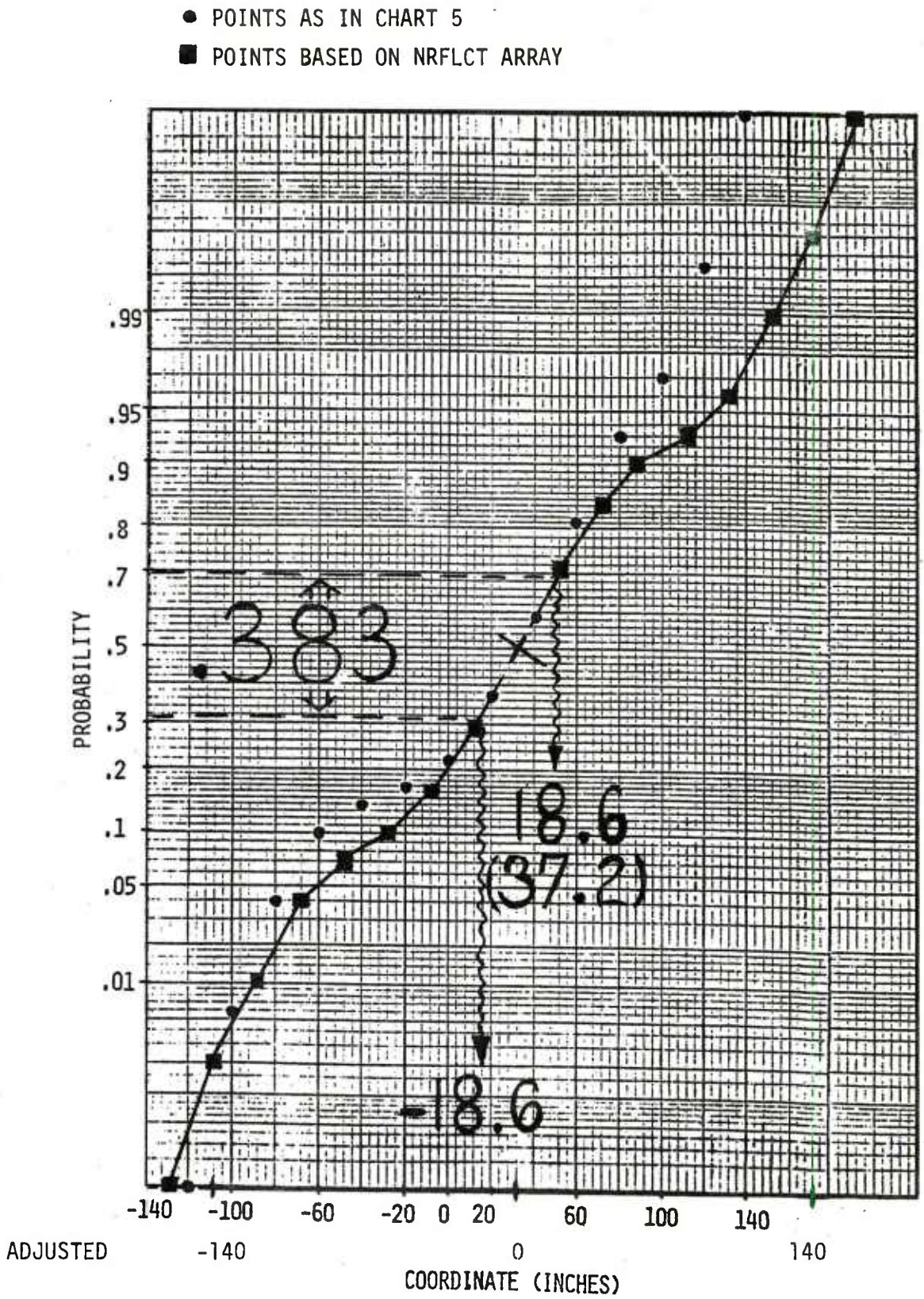


CHART 11 ESTIMATE OF 0.5 STANDARD DEVIATION

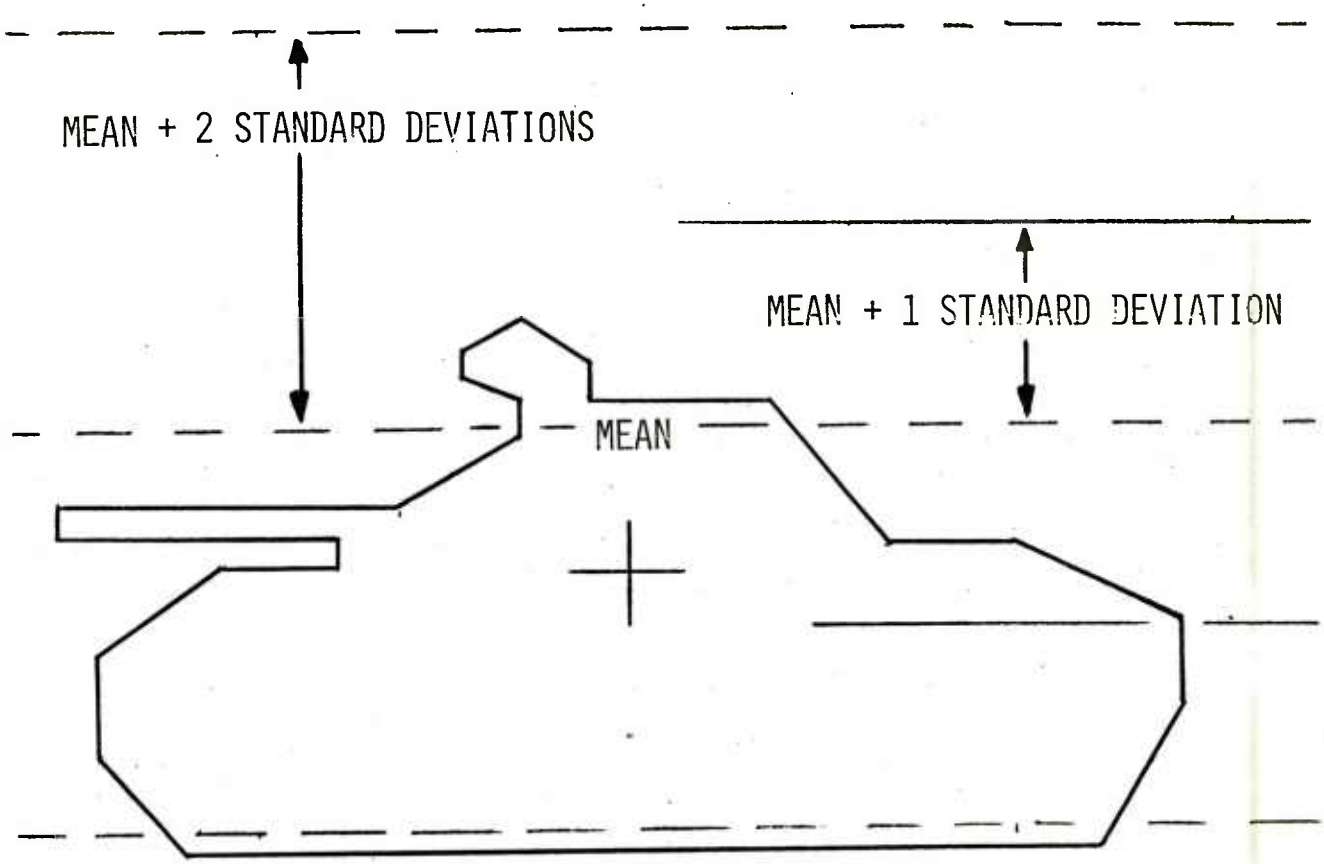


CHART 12 ILLUSTRATION OF DISTRIBUTION FOR MEAN OF 32 INCHES AND STANDARD DEVIATION OF 40 INCHES

deviation. For example, as is shown in Chart 11, a frequency of .383 is associated with the mean plus or minus 0.5 standard deviation. Vertical lines through .5 - (.383/2), which equals about .31, and through .5 + (.383/2), approximately .69, cross line segments joining points based on the NRFLCT array at intersections that correspond to adjusted horizontal scale values of -18.6 and 18.6 inches. The related standard deviation estimate is 37.2 inches. Similarly, standard deviation estimates based on 1.0 and 1.5 times the standard deviation turn out to be 39.9 and 53.4 inches respectively.

3. CONCLUSION. Consider again the context within which arose the need for the procedure explained in this paper. Chart 12 illustrates the information concerning the vertical coordinates of missing first rounds that is conveyed by the calculated mean and a standard deviation estimate of 40 inches, selected as a best estimate for the particular situation used as an illustrative example in this paper.

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